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(Continued from page 531)

FLUCTUATIONS IN THE MOON'S LONGITUDE IN RELATION TO METEOROLOGICAL VARIATIONS.

By RALPH E. DELURY.

As far back as the rainfall record at Upsala extends (1739), there appears to be a resemblance between it and the deviations of the moon's longitude (Newcomb); also, the tree-growths in California (corrected for age) show similarities during the same time, as well as for 12 cycles of 260 years in the same phase (deduced from the measurements given in *The Climatic Factor*, Ellsworth Huntingdon), thus:

	Mean Deviations in the Moon's Longitude	Mean yearly Rainfall Upsala	Mean Tree-growth per decade	
			1 cycle	12 cycles
1739-1839	+ 10″	40 cm.	7.3 mm.	6.8 mm.
1839-1910	— 4″	54 cm.	7.6 mm.	7.0 mm.

The last two cycles of the 60-year period in the moon's longitude (coefficient 3″, Brown), show marked similarity to rainfall at Upsala (corrected for tilt of large pulse), and to tree-growth. (Curves shown on lantern slide). Brown showed that the former coincide with two cycles of 60 or 70 years in the extent of the 11-year maxima of sun-spots, and also in the longitude of the earth and Mars.

It is worthy of note that the rainfall at Upsala in 1866 was 81 cm., the highest value of the whole record. From 1866-9 the mean yearly value was 62 cm., while the mean of the whole period from 1739 to the present was about 45 cm. During the interval of the excessive rainfall at Upsala the moon's longitude went through a sharp decrease, a fact

which has been associated with the Leonids, by H. H. Turner, but which may have been due to a change in the length of the day brought about by the meteorological changes.

The levels of the Great Lakes were examined, but one point only is worthy of note, namely, that the levels of Lake Erie show a marked similarity to the 11-year variation in sun-spots from 1790-1845 when the moon's deviations in longitude were positive, but from that time on, the minima of the Great Lakes do not show so definitely, as though the smaller 11-year pulse were annulled by a larger effect which caused greater rainfall in Upsala and which coincide with the negative values of the deviations from the theoretical values of the longitudes of the moon.

It would seem that great rainfall and tree-growth are associated with greatest negative values of deviations in the moon's longitude, or with most rapid rotation of the earth,—if that hypothesis be considered. Pulsations in the solar radiation would account for the meteorological variations and at the same time for the apparent and real variations in the moon and the planets. Such pulsations may in turn be associated with the primary or secondary action of varying amounts of cosmic matter in the solar system.

Turner has recently deduced a 240-year period in Chinese earthquakes, 0-1680 A.D., and he suggests these are due to pulses in the diameter of the earth which in turn would produce changes in the rotation of the earth thus accounting for the long-period fluctuation of the moon's longitude. In a later note I show a resemblance between this 240-year period in earthquakes and the tree-growths in California for the same interval, 0-1680 A.D., thus making it appear that the earthquakes may be due to the meteorological variations.

APPARENT RELATION BETWEEN CHINESE EARTHQUAKES AND CALIFORNIA TREE GROWTHS, 0-1680 A.D.

By Ralph E. DeLury.

From an examination of the records of Chinese earthquakes, H. H. Turner has recently deduced a period of 240 years (*Monthly Notices*, May, 1919). It shows a similar periodicity to the Nile Floods, with a change of phase. Turner makes the suggestion that a variation of the Earth's radius could account for the earthquakes and possibly at the same time for the fluctuations of the moon's longitude by changing the speed of rotation of the earth. The measurements of the tree-growths in California from *The Climatic Factor*, by Ellsworth Huntingdon, reveal a striking similarity to the curve of the Chinese earthquakes, thus: (E, for earthquakes, and F for tree-growth in mm. per decade for two decades, from pp 323-4 *The Climatic Factor*):

Date	+0		+240		+480		+720		+960		+1200		+1440		Total	Mean
	E	F	E	F	E	F	E	F	E	F	E	F	E	F	E	F
10	2	7.1	5	7.0	1	6.4	3	6.1	1	6.6	11	6.7	5	6.9	28	6.68
30	0	7.2	7	7.0	1	6.5	1	6.3	2	6.9	3	6.7	22	6.4	36	6.71
50	1	7.2	28	6.8	5	6.4	4	6.2	17	7.5	3	6.6	38	6.5	96	6.74
70	1	7.2	11	6.8	5	6.4	30	6.4	8	7.2	2	6.6	47	6.8	104	6.78
90	5	6.7	5	6.8	3	6.6	5	6.4	12	6.8	7	6.5	14	7.0	51	6.67
110	16	6.7	11	6.7	3	6.7	6	6.4	14	6.7	35	7.0	20	7.2	105	6.76
130	15	6.8	11	6.7	2	6.7	6	6.4	15	6.8	33	7.6	27	7.2	109	6.88
150	13	6.8	10	6.6	3	6.2	8	6.3	1	6.7	36	7.6	28	7.1	99	6.76
170	11	6.7	6	6.3	9	6.1	4	6.7	10	6.7	26	7.3	24	7.4	90	6.74
190	2	7.0	2	6.4	2	6.2	0	6.9	6	6.4	4	7.2	40	7.3	56	6.75
210	0	7.2	1	6.3	6	6.3	6	6.7	12	6.4	7	7.0	12	7.3	44	6.74
230	5	7.1	3	6.4	4	6.2	2	6.5	10	6.5	14	6.9	1	7.4	39	6.71

It seems reasonable to suggest that the meteorological variations produced simultaneous changes in the tree-growth and in the Chinese earthquakes.

LEVELS OF THE GREAT LAKES IN RELATION TO NUMBERS OF SUN-SPOTS.

By RALPH E. DELURY.

An examination of the records of the levels of the Great Lakes for the purpose of detecting long-period fluctuations resulted almost in failure, due to the lack of records up to 1850. A very full account of all the available data of the levels of Lake Erie from 1788 to 1854 are given in the *Canadian Journal* of 1854, by Major R. Lachlan. From 1860 to the present time the records are very complete for all of the lakes. The latter show some slight tendencies to increased level at or just after the maxima of sun-spots. The minima are not marked, partly due, no doubt, to the occurrences of volcanic activity causing increased cloudiness, and thus helping to keep up the lake levels during certain of the minima. During recent years, too, the cutting down of the forests and the building of canals and locks have no doubt modified the levels somewhat from their natural states. However, the levels for Lake Erie given in the above mentioned paper show a decided resemblance to the sun-spot variatons, as follows:

	Dates of Maxima of		Dates of Minima of	
	Sun-spots	Levels of Lake Erie	Sun-spots	Levels of Lake Erie
(1)	1788.1	1788-90	1798.3	1795-96
(2)	1805.2	1800-02	1810.6	1810-11
(3)	1816.4	1815	1823.3	1819-20
(4)	1829.9	1827-30	1833.9	1832
(5)	1837.2	1838	1843.5	1846
(6)	1848.1	1853		

Maxima, (1) and (5) were highest in both spots and levels. This period of agreement coincides (see a previous paper) with the time of small rainfall (at Upsala) relatively to sudden great increase in rain-

fall which has been fairly well maintained from 1840 to the present time, a variation which coincides in point of time with the decrease in the longitude of the moon. Possibly this large pulse in meteorological conditions has obliterated the effect of the smaller 11-year spot period during the last 70 or 80 years, as regards the levels of the Great Lakes, at least.

SIMULTANEOUS SPECTROSCOPIC OBSERVATIONS OF THE RATE OF ROTATION IN NORTH AND SOUTH SOLAR HEMISPHERES.

By RALPH E. DELURY AND JOHN L. O'CONNOR.

In June 1911, J. B. Hubrecht obtained at Cambridge, England, observations of the north and south hemispheres independently by observing at points on the limb separated by 90°. He found that the north hemisphere yielded velocities of rotation about 5 per cent higher than the south. As this might possibly be explained by the fact that the observations were not made precisely at the same time, and that a blended spectrum of terrestrial haze might have affected the southern observations more than the northern, it seemed advisable to make observations at four quadrantal points around the limb at the same time. This has been done by employing four reflecting prisms at four points at the limb separated in sequence by 90°. These prisms reflect the limb light to four other reflecting prisms placed over the slit in compact formation, so that it is possible to make sets of observations at say 0°, 90°, 180°, 270°, or 45°, 135°, 225°, 315°, or any desired combination. On the plates may be included, arc, centre and iodine spectra at the same time, 9 strips of spectra being photgraphed and spaced 1 mm. from the centre of one strip to the middle of the next.

Measurements of 85 plates have been made at the 45° positions with the following results:

	λ	Number of Observations	Date	North, 45°	South, 45°
O'Connor	5590	65, 6 lines	June, Dec., 1918		
			June, 1919	1.13 km : sec.	1.19 km : sec.
De Lury	5170	20, 12 lines	June, 1918		
			June, 1919	1.13 km : sec.	1.19 km ; sec.

The Cambridge results were just the reverse of these:

Hubrecht	4350	16, 30 lines	June, 1911	1.19 km : sec.	1.13 km : sec.

These results are rather surprising. They may be due to an obscure source of error, or they may be due to real variations on the surface of the sun which vary from time to time, or they may be due to solar or interplanetary matter in the line of one hemisphere more than in the line of the other, affecting the spectra by blending with them varying amounts of general sunlight. It will require many observations to de-

cide these points. Though it is convenient to make the observations when we are in or near the solar equator, they should not be confined to these two periods in the year.

THE PERIODOGRAPH AND ITS APPLICATION TO VARIABLE STAR PERIODS AND OTHER PROBLEMS.

By A. E. Douglass.

The periodograph is an optical analyzing instrument in which light is passed through the area between a plotted curve and the X-axis, in order to turn the variations of the curve into photometric values. A cylindrical lens forms an image on an analyzing plate and periods are shown by a kind of interference fringe. In using this instrument to determine variable star periods, the observed magnitudes are plotted as departures from a mean, and a slightly tinted glass is placed over the minima. When the interference fringes are found to be alternately colored and white, the period is indicated. It was estimated that, after plotting, only five or ten minutes were required in determining a period with an accuracy comparable to a least square solution. By applying this instrument to the study of climatic cycles in trees, there is some evidence that an 11-year cycle was operating 3000 years ago, and that different centuries and possibly different regions are characterized by different combinations of short period cycles.

PRELIMINARY RESULTS OF A COMPARATIVE TEST OF THE 60-INCH AND 100-INCH TELESCOPES OF THE MOUNT WILSON OBSERVATORY.

By George E. Hale.

The close proximity on Mount Wilson of the 60-inch and 100-inch reflecting telescopes renders possible a comparative test of two similar instruments of large aperture. In order to make the results strictly comparable, the observations are preferably made simultaneously, and when these are photographic, the plates employed are taken from the same box and developed together for the same time. Other precautions necessary to eliminate sources of uncertainty are also observed.

The first simultaneous comparative tests of the series (which will be continued as opportunity offers through several months) were made on August 13, 1919. The spectrum of the star ϵ Andromedae was photographed on Seed 30 plates with the two telescopes, using spectrographs having nearly identical optical constants, mounted at the Cassegrain focus. For the 60-inch the equivalent focal length at this point is 80 feet, while for the 100-inch it is 134 feet. The exposures on ϵ Andromedae were made by Dr. Strömberg with the 60-inch and by Dr.

Merrill with the 100-inch, under good conditions of seeing.

Thirty-three spectrograms were secured for comparison. From twenty of these Dr. Strömberg finds the following mean ratios of exposure-times required to give the same intensities and photographic resolution with the two instruments:

Region	λ4000	λ4300	λ4500
Mean ratio	4.5	3.2	3.3

As the light undergoes three reflections in each telescope, and as the small mirrors cut out nearly the same proportion of light in both cases, the theoretical ration of exposure time would be $(100/60)^2 = 2.78$. The presence of the plane mirror in the optical train of the spectrograph of the 60-inch telescope, and the fact that the three mirrors of the 100-inch telescope have been more recently silvered than those of the 60-inch, probably accounts for the comparatively high value of the ratio at λ4000 (4.5), as the comparison spectra show no such change of relative intensity with wave-length. But these differences cannot affect the brightness at λ4500 by more than 15%, judging from the constancy of the exposure times for stars of a given magnitude required with the 60-inch throughout the dry summer season. Another comparison will be made after the mirrors of the 60-inch have been resilvered.

A second comparative test, not based upon simultaneous exposures, is afforded by Dr. Merrill's experience with stars of Class Md. 201 of these interesting objects, brighter than 9.0 magnitude at maximum, are known north of −30°. With the 60-inch nearly all of these stars can be observed for the bright lines with exposures not exceeding two hours. For the great majority, however, exposures of five hours or more are required with this telescope to yield a measureable absorption spectrum with the spectrographs already mentioned. In fact, so few stars can be effectively observed for both dark and bright lines that it would be hardly advisable to enter upon an extensive study of these objects with the 60-inch.

The greater light-gathering power of the 100-inch, however, renders a study perfectly feasible. With this telescope, using the spectrograph mentioned above at the 134 foot Cassegrain focus, Dr. Merrill has obtained good photographs of the absorption spectrum (up to Hγ) of RY Herculis, 8.8 visual magnitude, in two hours, and of brighter stars of the same class with shorter exposures.

Dr. Shapley, who is continuing his investigation of star clusters with the 100-inch telescope, finds a similar gain of about one magnitude. With the small slitless spectrograph* mounted on the double-slide plate-holder at the 134 foot focus of the 100-inch, the exposure

*This spectrograph has a collimator of 18 inches focal length, a 39° prism of O.102 glass, and a camera of 3 inches focal length. This scale is Hγ — K = 0.9 mm.

times for stars in the globular cluster Messier 11 are about as follows:

Photographic magnitude	Exposure
12	5 minutes
13	15 "

A further advantage results from the greater scale of the cluster in this focus of the 100-inch (ratio to that of the 60-inch = 134/80), which permits the spectra of closer stars to be photographed separately. This scale may be seen from the accompanying slide, which is a contact copy of a negative of the central part of the globular cluster Messier 13, made by Mr. Pease on August 17 at the 134 foot focus of the 100-inch telescope with an exposure of 30 minutes. It was not feasible to make a simultaneous exposure on the same evening at the 80 foot focus of the 60-inch, but from a comparison with other plates it is evident that with good seeing the 100-inch will give decidedly fainter stars at this focus than the 60-inch, in spite of the severe demands imposed by the greater equivalent focal length of the 100-inch. The large scale of these photographs will permit the magnitudes of stars in the central parts of the cluster to be determined with less difficulty from the Eberhard effect than has been experienced with the 60-inch. Simultaneous cluster photographs made with the two telescopes when the seeing was very poor (1 on a scale of 10) show decidedly better results for the 60-inch, as might be expected from its much shorter focal length.

A few photographs of the moon have been made at the 134 foot focus of the 100-inch by Mr. Pease, with very satisfactory results, but not under conditions of seeing sufficiently good to permit the finest accessible details to be recorded. The accompanying slide of Copernicus, a contact copy of a negative made on August 18, will suffice to illustrate the scale of the negatives and the character of the details registered. The extraordinarily minute structure on the moon which I have seen visually on several occasions with the 100-inch, and the large image available at the 134 foot focus, indicate that this telescope is exceptionally well adapted for lunar photography.

One of the most promising applications of the 100-inch telescope is illustrated by some photographs of Campbell's star with hydrogen atmosphere, B D + 30°3639. Enlargements were shown of photographs of this star made by Mr. Pease at the 134 foot focus on August 17 with exposures of five and ten minutes respectively. A rift in the hydrogen atmosphere, confirmed by several other plates, is plainly shown. Minute details in several very small planetary nebulae have also been successfully photographed by Mr. Pease at the 134 foot focus.

Hitherto no definite tests have been made in the principal focus of the 100-inch telescope, as the Newtonian "cage" is not yet quite completed. It may be of interest, however, to show a photograph of the Ring Nebula in Lyra, made on July 16 in the principal focus with an

exposure of ten minutes. Mr. Pease and Dr. Anderson, who had been examining the figure of the large mirror, were both standing on a small platform mounted temporarily in the middle of the unfinished focal plane "cage." During the exposure, made by Mr. Pease with a double-slide plate-holder supported in the focal plane, they were carried with the instrument by the driving-clock. Naturally these circumstances were not favorable to good seeing, steadiness of the tube, and accurate guiding, but it is doubtful whether finer details of structure than those shown in this photograph of the Ring Nebula have ever been obtained with the 60-inch under the most perfect conditions. It should be noted that the nebula was out of the axis of the large mirror, which was not then in adjustment. As the Newtonian "cage" and observing platform are nearly ready for use, a real test of the performance of the 100-inch at its principal focus should soon be feasible.

List of Slides.

(1) Dome of 100-inch telescope, from 150-foot tower.
(2) 100-inch telescope.
(3) Spectra of ϵ Andromedae, with 100-inch telescope (exposure 4 minutes), and with 60-inch telescope (exposure 12 minutes).
(4) Spectra of ϵ Andromedae(photographed with 100-inch telescope (exposures 2 minutes, 6 minutes, and 10 minutes).
(5) Star cluster M 13 Herculis, photographed in 134-foot focus of 100-inch telescope, with exposure of 30 minutes. (Scale of original negative.)
(6) Lunar crater Copernicus, photographed in 134-foot focus of 100-inch telescope. (Scale of original negative.)
(7) Campbell's star with hydrogen atmosphere, photographed at 134-foot focus of 100-inch telescope.
(8) Ring Nebula in Lyra, photographed in principal focus of 100-inch telescope (exposure 10 minutes).

RATES OF THE STANDARD SIDEREAL CLOCKS AT THE U. S. NAVAL OBSERVATORY.

By J. C. Hammond and C. B. Watts.

The clock vault at the U. S. Naval Observatory contains three Riefler sidereal clocks which are maintained at practically constant temperature and pressure throughout the year.

The definitive rates of these clocks have recently been determined from observations with the six-inch transit circle from 1911 to 1918. The hourly rates of these clocks seldom change more than $0^s.001$ in a five day period which means that the accumulated uncertainty in the value of the clock correction in that time should not amount to more than $0^s.06$ or $0^s.07$.

The time signals, which are sent out by the time service at the Observatory and which are based on these clocks, are seldom in error by more than one-tenth of a second even after a week of cloudy weather when no observations can be made.

NOTE ON THE SPECTRUM OF NOVA AQUILAE NO. 3.

By W. E. Harper.

Since last autumn the spectrum of the Nova has undergone slight modifications in the region covered by our plates, namely from λ3900 to λ5020. These changes may be summed up by stating that the hydrogen emissions below $H\beta$ have vanished—there is a trace of $H\beta$ still—and the remaining nebular emissions λ5007, λ4959 and λ4363 are more complicated by reason of their being crossed by numerous absorption lines. The emission band, which extended roughly from λ4600 to λ4700, is now very faint relative to the other emissions. The continuous spectrum which on December 15th last was a negligible quantity seems to vary in intensity and is fairly strong on plates taken in the month of June this year. Whether this variation is coincident with variation in light cannot be stated, as definite determinations of the magnitude were not made. The star has decreased in brightness, speaking roughly, from magnitude 6.5 when first seen in March this spring to magnitude 7.5 at present.

The main portions of the N_1 and N_2 emission bands are well defined, about 12 angstroms in width, with centres at wave-lengths λ5007.20 and λ4959.42 respectively. The λ4363 band is about 55 angstroms wide and its centre is approximately λ4363.8. Noticeable features of the spectrum are the narrow, apparently isolated, emission strips about 27 angstroms to the violet of the centre of each of the emission bands. They occupy the identical positions that the least displaced absorption lines did in the case of the hydrogen emissions when last seen last summer and which if interpreted as velocity effects represented an approach of 1750 km per sec. These strips are, however, the edges of the main emission bands severed by intervening absorption as can be traced on the plates. Numerous narrow and well-defined absorption lines cross the emission bands, particularly λ4363, and their wave-lengths have been determined.

THE ORBIT OF THE SPECTROSCOPIC BINARY ε DELPHINI.

By W. E. Harper.

Twenty spectrograms obtained of this known binary (α 1900 = 20^h $33^m.0$, δ 1900 = + 11° 02′, class A2, photographic magnitude 5.49) during this present summer with the single prism spectrograph attached to the 72-inch reflector form the basis for the determination of the orbit. Six plates made at Ottawa last year served to decide between two possible periods as adduced from connecting up the three Mount Wilson plates, made in 1911, with our own.

The spectrum lines are quite suitable for measurement, the hydrogen lines, calcium K and magnesium λ4481 being narrow and well defined.

In addition to these there are numerous fainter metallic lines so that with 12 to 20 always measured it was expected that the probable error of a single plate would be much lower than was actually the case, namely ± 1.9 km per sec.

The elements determined by a least-squares solution are as follows:

$$\begin{aligned} P &= 10.9960 \text{ days} \\ e &= 0.252 \pm .025 \\ \omega &= 60°.81 \pm 8°.19 \\ \gamma &= -5.60 \text{ km} \pm 0.52 \text{ km} \\ K &= 26.72 \text{ km} \pm 0.73 \text{ km} \\ T &= \text{J.D. } 2{,}422{,}095.816 \pm 0.237 \text{ days} \\ a \sin i &= 3{,}909{,}500 \text{ km} \\ \frac{m_1 \sin^3 i}{(m + m_1)^2} &= 0.020 \odot \end{aligned}$$

THE ORBIT OF THE SPECTROSCOPIC BINARY BOSS 4507.

By W. E. Harper.

Twenty-three spectrograms of this star (α 1900 = $17^h\ 44^m.4$, δ 1900 = + 47° 39′, magnitude 6.34, class A0) whose binary character was not previously known, were obtained with the single-prism spectrograph attached to the 72-inch reflector between the end of May and the middle of July of this year.

The hydrogen lines are much narrower than is usually the case for this type and they, with λ4481 and the K line, were the best measurable. Numerous other weaker metallic lines are present and 12 to 20 were measured on each plate. The least squares solution gave the following values of the elements:

$$\begin{aligned} P &= 2.82424 \text{ days} \pm .00011 \text{ days} \\ e &= .017 \pm .007 \\ \omega &= 30° \\ \gamma &= -27.30 \text{ km} \pm .30 \text{ km} \\ K &= 60.15 \text{ km} \pm .47 \text{ km} \\ a \sin i &= 2{,}335{,}700 \text{ km} \\ \frac{m_1 \sin^3 i}{(m + m_1)^2} &= 0.06 \odot \end{aligned}$$

The probable error of a plate of ± 1.2 km per sec. is extremely satisfactory for single prism work for a spectrum of only moderate sharpness and speaks well for the instrumental equipment used.

A DESIDERATUM IN SOLVING KEPLER'S PROBLEM.

By H. A. Howe.

Many of the greatest mathematicians have sought to solve Kepler's Problem by direct methods, but most of the methods are cumbersome. In the following method an approximate value, E', of the eccentric anomaly is obtained, where e and M are known, by the formula

$$\tan (E' - M) = \frac{e \sin M}{1 - e \cos M},$$

or by

$$\tan (E' - \tfrac{1}{2}M) = \frac{1+e}{1-e} \tan \tfrac{1}{2} M .$$

Then, if E be the true value of the eccentric anomaly, we have

$$E' - E = \frac{2\eta}{1 - e \cos (E' - \eta)}$$

where

$$2\eta = (E' - M) - \sin (E' - M) .$$

This formula for $E' - E$, which was published by the writer in *A.N.* 2322, is exceedingly accurate. Its error never reaches 0".001 when ϕ, the inverse sine of the eccentricity, is less than 10°. When $\phi = 15°$, the average value of the error is 0".005.

Bauschinger in his *Tafeln zur Theoretischen Astronomie*, solves two examples by European methods, using certain auxiliary tables. The same examples have been solved by the American method outlined above. In the first example the European solution occupies twenty-three lines, and uses seven six-place logarithms; the American solution occupies fifteen lines and uses only two six-place logarithms. In the second example the European solution occupies thirty-six lines, twelve of which are filled by seven-figure logarithms; the American solution occupies twenty-seven lines, only nine of which contain seven-place logarithms.

Herz's method, exploited by Oppolzer in his great *Lehrbuch zur Bahnbestimmung*, is more cumbrous yet.

The desideratum for making the American method available for computers is a table giving the values of η and $\log 2\eta$ with the argument $E' - M$. If it be possible to express $1 - e \cos (E' - \eta)$ as a function of $E' - M$, the solution of Kepler's Problem for orbits of asteroids will become remarkably easy.

THE RED AND INFRA-RED ARC SPECTRA OF EIGHT ELEMENTS.

By C. C. Kiess and W. F. Meggers.

Wave-lengths in the red and infra-red arc spectra of silicon, titanium, vanadium, chromium, manganese, molybdenum, tungsten and uranium have been measured at the Bureau of Standards in continuation of a program inaugurated several years ago. The photographs used in the investigation were made on plates sensitized to the spectral regions studied with the dyes pinacyanol, dicyanin, and dicyanin A. The concave grating spectrograph was the instrument used. A total of 2690 spectrum lines has been measured, distributed among the various elements as follows:

Element	No. Lines	Limiting Wave-Lengths
Silicon	65	5645 A - 9233 A
Titanium	200	5503 - 9744
Vanadium	270	5504 - 9522
Chromium	145	5564 - 9735
Manganese	225	5505 - 9576
Molybdenum	565	5501 - 9721
Tungsten	485	5500 - 9159
Uranium	735	5504 - 9530

The long wave regions of the spectra of chromium and manganese are characterized by several groups of strong lines. Vanadium has numerous sharp lines of medium intensity but has superposed on its spectrum several bands. Titanium also gives a number of bands in the red, its line spectrum, however, being relatively weak. No very strong lines characterize the spectra of molybdenum, tungsten, or uranium. However, their spectra are rich in faint lines which are measured with difficulty on a background of continuous spectrum. In all the spectra, with the exception of that of silicon, pairs and groups of lines with constant frequency differences have been found.

COLOR INDEX OF PLANETS.

By Edward S. King.

Photovisual as well as photographic magnitudes for the brighter planets have been recently derived, which give values for the color index of each. The recent measures have been made with the 8-inch Draper and the 10-inch Metcalf telescopes. The usual out-of-focus method was employed. For the photovisual values, yellow sensitive plates were used with a yellow filter which totally cuts off the blue rays. Hence, the color index is derived from the comparison of the blue light with the yellow light emanating from the planet. As the standard of color I have accepted that of stars of spectral Class A.

The results in part are given in the following table.

Planet	Photographic Magn.	Photovisual Magn.	Color Index
Venus	−3.23	−4.19	0.96
Mars	−0.41	−2.14	1.73
Jupiter	−1.59	−2.57	0.98
Saturn	1.69	0.26	1.43
Uranus	6.45	....	0.94

The values for the magnitude of Venus have been reduced to superior conjunction; for the other planets they are given for mean opposition. For the color index of Uranus, the comparison was made with the visual magnitude given in *H.A.* **46**. All the values of color index vary more or less from those given in *H.A.* **59**, which were found by comparison with the visual measures made at Potsdam.

A lantern slide was exhibited showing images of Venus, Vega, and Arcturus, the two portions of each image having been photographed in blue and yellow light by the method which the writer presented at last summer's meeting. The images show that Venus as to color appears similar to Arcturus, and quite unlike Vega. Therefore the slide demonstrates that the color index of Venus under the conditions of observation was fully equal to that of Arcturus. However, the value is enhanced by the difference in altitude. The altitude of Venus, when observed, was about 18 degrees, while that of Arcturus was 62 degrees. The difference in absorption of the blue and yellow rays for these altitudes is about 0.45 magn. Subtracting 0.45 from 1.38, the color index of Arcturus as given in *H.A.* **76**, page 120, we have 0.93 as the color index of Venus, which compares favorably with the value in the table above.

PHOTOGRAPHIC OBSERVATIONS OF THE GREAT NEBULA IN ORION.

By C. O. Lampland.

A brief report was given of the photographic observations of the Great Nebula in Orion carried on at the Lowell Observatory. The results are upon the examination of several series of photographs, with exposures of different duration, taken with the 40-inch reflector. Over one hundred photographs have thus far been made, beginning in 1911.

Great care has been taken to make the negatives in as uniform a manner as possible in order that the plates of each series, for different epochs, should be suitable for intercomparison. The photographs were made primarily for examination of nebulous detail for possible variations in position, form or brightness. The examinations have been made with a Zeiss comparator equipped with a monocular Blink-Mikroskop. So far as the nebulous detail is concerned no certain changes

have been observed in the region covered by the plates examined. The slight differences noted in some pairs of plates cannot at present be considered more than the inevitable small variations that may be due to photographic effects. All parts of the nebula in which such possible changes have been observed will be carefully examined in further work. It is planned to continue the series of photographs.

As by-products of the work a large number of variables have been observed and motion, not previously known so far as I am aware, certainly detected for one faint star. Many of these variables have already been announced but confirmatory observations of some of them should be of value. Most of the new variables discovered are comparatively faint. The need of great caution in observing faint stars situated in nebulous matter has been repeatedly emphasized by observers of long experience. I believe that sufficient care has been taken in this work to make the observations of the variables trustworthy.

A more complete account of the examination of the photographs will be published later.

STAR TABLES GOOD TO THE YEAR 2000 FOR CIVIL ENGINEERS AND NAVIGATORS.

By H. C. Lord.

If he desires to secure the full accuracy obtainable with an instrument reading to ten seconds of arc, the civil engineer or navigator is compelled to depend for his data upon one of the annual ephemerides published by the Government which not only reaches an accuracy far beyond his needs but also compels him to obtain a new copy each year. An effort to provide my own students of geodetic astronomy with an ephemeris of certain stars which should reach a sufficient degree of accuracy and at the same time extend over a long period and bring out the fundamental principles involved in the reduction to apparent place, forms the subject of the present paper. Thus far the tables have been confined to the northern hemisphere but they could be easily extended to the stars in the southern. While tables giving the mean places, precession, and secular variation, for the list of stars chosen as well as tables whereby the sidereal time of mean noon for any date can be easily and rapidly computed are included, I shall confine myself to those which cover the reduction to apparent place.

In the Besselian Star-Numbers, if we neglect all of the short period terms and all but the two largest of the long period terms, we may write the values of A and B as follows:

$$A = t - 0.342 \sin \Omega - 0.025 \sin 2L$$
$$B = -9''.21 \cos \Omega - 0''.55 \cos 2L .$$

In the above expressions the long period terms neglected can never

amount to 0.00832 in A and 0".128 in B, while all of the neglected terms can never amount to five per cent of the largest term in A and three per cent in B.

We also have the following:

$$a = 3^s.073 + 1^s.336 \sin \alpha_0 \tan \delta_0$$
$$b = (1/15 \cos \alpha_0 \tan \delta_0 .$$

The sum of the products, Aa and Bb, will then consist of three parts, namely, those containing t, those containing some function of Ω, and those containing some function of $2L$. We will consider each separately.

Terms Depending upon t. These terms are simply the effect of precession for the fraction of the year and can be easily determined, where the precession for the year is included in the tables of mean places, or else interpolated where the mean place is given for a series of years as is done in the case of Polaris.

Terms Depending upon Node. For these terms we have

$$Aa = -(1^s.051 + 0^s.457 \sin \alpha_0 \tan \delta_0) \sin \Omega$$
$$Bb = -0^s.614 \cos \alpha_0 \tan \delta_0 \cos \Omega$$

In the above expressions putting

$$n \cos N = 1^s.051 + 0^s.457 \sin \alpha_0 \tan \delta_0$$
$$n \sin N = 0^s.614 \cos \alpha_0 \tan \delta_0 ,$$

we will have, after reduction, as the part of $Aa + Bb$ depending upon node

$$-n \sin (\Omega + N) .$$

From this it is evident that the terms of nutation which depend upon node can be expressed as a simple harmonic motion in which the phase and amplitude are constant over long periods of time. A similar expression can be obtained for the terms in $2L$ and for the sum of the two terms Cc and Dd which give the aberration. E can be neglected, as it is always less than one second of an arc. Hence it follows that a star's reduction to apparent place can be expressed as the sum of the precession for the fraction of the year and three simple harmonic motions the phase and amplitudes of which are constant over long periods of time. Further it will become evident that the term depending upon $2L$ can nearly always be neglected. The values of these constants for both coordinates are given for twenty-one stars north of the equator and south of 46° north declination.

In the case of Polaris, however, the motion in right ascension is so rapid that the values of these constants vary quite appreciably and this secular change can not be neglected. The nutation was computed as follows. For the terms depending upon $2L$, the amplitude and phase angle were computed for 1960 and then considered as constant. For the terms depending upon node, the amplitude and phase angle were

computed for 1920 and each twenty years thereafter, the results plotted on cross section paper, a smooth curve drawn through them, and the values read from this curve for each year; with the constants thus determined the instantaneous values of the nutation were determined. The aberration was computed as follows. The amplitude and phase angle was computed for each of the years 1920, 1960, and 2000 and the aberration computed for every ten days of those years. It was then found that the values for all other years could be obtained by straight line interpolation from the values for 1920. It should also be stated that the mean places of Polaris were computed with all rigor by the methods given by Newcomb in his *Compendium of Spherical Astronomy* for close circumpolar stars.

It should be added that in order to use these tables there must be provided a table which gives the longitude of the moon's node and one which gives the sun's longitude. The first was computed from the formula

$$\Omega = 259^\circ\ 10'.8 - 19'.32826\ (T - 1900 + N/365).$$

Here N is the number of leap years after 1900 inclusive of T if it be a leap year. This gives the value of Node for Greenwich Mean Noon on January 0 for all ordinary years, and on January 1 for all leap years. After this table had been computed a similar one was found in Newcomb's *Compendium of Spherical Astronomy*. The table which gives the sun's longitude changes from year to year but a careful investigation over a number of years showed that an average table could be made which would represent all years up to 2000 with an error of less than $1^\circ.5$ which is sufficiently accurate. A three-place table of natural sines combined with a slide rule makes the application of these tables quite easy.

FALSE SPECTRA PRODUCED BY GRATINGS.

By W. F. Meggers, C. C. Kiess and F. M. Walters, Jr.

Practically all gratings give spurious reproductions or "ghosts" of intense lines diffracted from them. Rowland*, in his theory of gratings, has shown that the positions and intensities of the ghosts are calculable if the ruling error is known. Rowland's theory, however, accounts only for those ghosts close to and symmetrically placed with respect to the exciting line.

While investigating the Schumann region with a grating spectrograph, Lyman† discovered a new type of spurious lines not accounted for by Rowland's theory. These false lines occur in pairs about points

*Rowland, *Physical Papers*, p. 537ff.
†*Physical Review*, **12**, 1, 1901; and **16**, 257, 1903.

in the spectrum of apparent wave-lengths 2/3 and 1/3 those of the exciting lines.

Recently, during investigations of the infra-red spectra of certain chemical elements, it was found that the grating spectrograph of the Bureau of Standards produces false spectra which bear definite relations to the exciting radiations. These false spectra are of the type discovered by Lyman, but the apparent wave-lengths are grouped about points in the spectrum which are multiples of 1/5 the exciting wave-length instead of 1/3. The importance of knowing definitely the "instrumental constants" of a grating will be appreciated when it is realized that the false lines, in appearance, are indistinguishable from real lines, and occur in all regions of the spectrum with intensities equal to those of the fainter real lines.

The following table gives the positions and character of the "ghosts" that have already been observed with the concave grating of the Bureau of Standards, which has a ruled surface of nearly six inches with 7500 lines per inch. The table gives not only the "ghosts" of the Lyman type but also the ordinary "ghosts" indicated by Rowland's theory.

GHOSTS OBSERVED WITH CONCAVE GRATING RULED WITH 7500 LINES PER INCH.

Factor	Character and notes
$\lambda g = (3/5 + 1/1500)\lambda$	Strong. Lyman type
$\lambda g = (4/5 - 1/750)\lambda$	" " "
$\lambda g = (1 \pm n/375)\lambda$	Strong, for n = 1 and 4; weak, for n = 2, 3, 5 and 6. Rowland type.
$\lambda g = (6/5 + 1/750)\lambda$	Strong. Lyman type
$\lambda g = (7/5 - 1/1500)\lambda$	" " "
$\lambda g = (7/5 + 2/750)\lambda$	Weak. " "
$\lambda g = (8/5 - 2/750)\lambda$	" " "
$\lambda g = (8/5 + 1/1500)\lambda$	Strong. " "
$\lambda g = (9/5 - 1/750)\lambda$	" " "
$\lambda g = (9/5 + 1/1500)\lambda$	Weak. " "

Other gratings, kindly loaned by the Johns Hopkins University, are being investigated in an attempt to determine the cause of the false lines and their relation to the methods of ruling. The details of these investigations will appear later in the *Scientific Papers of the Bureau of Standards.*

[*To be continued.*]

THE OCCULTATION OF BETA CAPRICORNI 1919, NOV. 27 AS VISIBLE IN THE UNITED STATES.

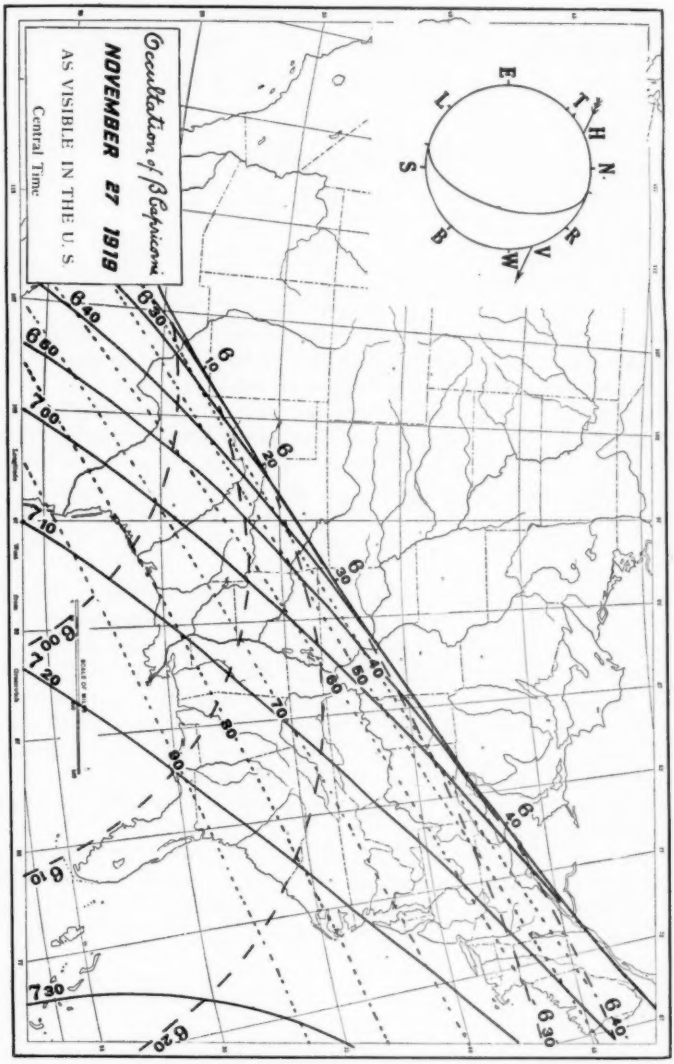
WILLIAM F. RIGGE.

The brightest star to be eclipsed by the Moon at a seasonable hour of the night for the United States in the course of the next two years is β Capricorni, of the 3.2 magnitude, whose occultation will take place on November 27 between 6:00 and 7:30 P. M., central time, with the Moon about five days old. Although visible only to the southern and eastern states, this occultation will appeal more to the amateur than that of the last similar object, π Sagittarii, of the 3.0 magnitude, on August 18-19 of last year, which occurred near midnight with the Moon about twelve days old.

The annexed map will give us the particulars. The broken or dashed lines marked from 6:00 to 6:40 give the central times of the immersion, or disappearance, of the star behind the advancing dark limb of the Moon, while the full lines marked from 6:30 to 7:30 give the times of its emersion, or reappearance, at the Moon's bright limb. The dotted lines marked from 40 to 90 show the position angles of the star at the emersion as counted from the Moon's north point towards the west. It will be of service to know that the Moon's north cusp is then 16° to the right or west of its north point, so that the position angles of the star as counted from the cusp will be 16° less than those shown on the map. The times and angles given may be erroneous by several minutes and degrees because, when the required data are close to the limit line and the Moon is low in the sky, the graphic method that was used is at a great disadvantage.

The insert shows the Moon as it will appear in Washington, D. C. The cardinal points N S E W and the position of the cusps in reference to them are the same for all observers in the world, but the points T B L R—top, bottom, left, right—as well as H and V, the points of immersion and emersion, are purely local. The arrow HV shows the apparent relative path of the star.

Observers situated on the limit line or a short distance beyond it will enjoy seeing the close conjunction, the times of which are marked on this line from 6:10 to 6:40. The best way of observing an occultation as well as a very close conjunction is, of course, with a telescope, and the instantaneous suddenness with which a bright star disappears at the Moon's dark edge is really startling to one that sees it for the first time.


Occultation of β Capricorni
NOVEMBER 27 1919
AS VISIBLE IN THE U. S.
Central Time
E
T
H
N
L
S
B
R
V
W
6 30
6 40
6 10
6
6 20
6 50
7 00
7 10
7 20
7 30
6 00
6 30
6 40

SUSPECTED VARIABLE STAR IN THE TRAPEZIUM OF THE ORION NEBULA.

J. A. PARKHURST.

The faintest of the four stars forming the trapezium in the Orion nebula, Bond 624, was reported by Goos in *Astronomische Nachrichten* 4945 as about 11th magnitude on 1917 Feb. 14 and 1918 Feb. 17, and normal brightness, about 8th magnitude on 1917 Dec. 27. In Observation Circular No. 6 of the *Nachrichten*, Hartwig found it about half a magnitude fainter than normal August 28-29, 1919.

These reports led me to examine the series of plates of the Orion Nebula which I have taken with the Yerkes 40-inch refractor. These plates, 103 in number, taken between 1900 Sept. 20 and 1919 March 19, gave no certain indication of change of the star in question; the apparent variations, which did not exceed a quarter of a magnitude, might be caused by differences in the quality of the plates and conditions of exposure.

Serious systematic errors may easily arise in attempting to compare stars surrounded by dense nebulosity, like the trapezium stars, with other stars seen against a background of dark sky. Both the eye and the photographic plate would seem to be liable to such errors, which might have a similar or an opposite effect, but which might be of the same order of magnitude. In comparing the above-mentioned plates it seemed safest to rely mainly on the appearance of the four trapezium stars, in spite of the fact that the suspected variable is the faintest of the four; rather than to depend on comparisons with stars having an entirely different background.

It does not seem advisable at this time to publish the long list of dates of the 103 plates; but merely to call attention to the data which are available if needed to check a period of variation. Both visual and photographic observations are now being made at this observatory.

Yerkes Observatory, 1919 Oct. 3.

Fig. 2
Nov. 12
23°8
9d

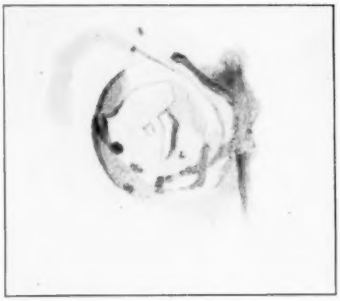


Fig. 3
Nov. 13
36°8
10d

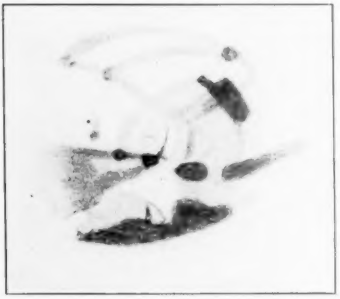


Fig. 6
Nov. 16
72°0
13d

Fig. 7
Nov. 17
85°0
14d

Fig. 10
Nov. 21
135°1
18d

Fig. 11
Nov. 22
147°3
19d

DRAWINGS OF THE LUNAR CRATER ERATOSTHENES

Fig. 4
Nov. 14
49°6
11d

Fig. 5
Nov. 15
59°5
12d

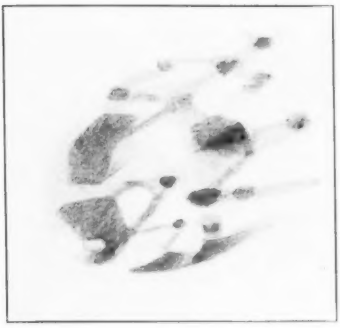


Fig. 8
Nov. 18
100°7
15d

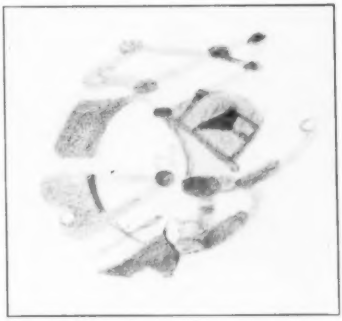


Fig. 9
Nov. 19
109°7
16d

Fig. 12
Nov. 23
160°1
20d

Fig. 13
Nov. 24
173°3
21d

DRAWINGS OF THE LUNAR CRATER ERATOSTHENES

ERATOSTHENES I, A STUDY FOR THE AMATEUR.

W. H. PICKERING.

It is proposed to prepare two or more papers on Eratosthenes, the first one for the amateur furnished with a small telescope, and the others for an observer possessing a somewhat more powerful equipment. It seems to be a general impression that the growth of the lunar vegetation and other interesting changes on the Moon can only be detected and observed by professional selenographers, with powerful telescopes, in the very best of climates. In order to controvert this idea the writer concluded to make the present set of drawings with a telescope of only 3 inches aperture, furnished with a half-inch eyepiece, giving a magnification of 90. While a more powerful telescope shows that some of the accompanying drawings should be slightly altered in some of their finer details, yet they are substantially correct, and have been left as they were originally drawn. They may be compared with the set of twelve photographs of this crater taken in 1901 with a 6-inch aperture, and published in the Harvard Annals **53**, Plates II, III, and IV. Four of these photographs are reproduced here in Plates XLVI and XLVII.

The drawings were made without any assistance whatever from the photographs, and the latter were not looked at until the drawings had been finished. Nevertheless they confirm one another fairly well. The two most difficult figures to draw were those of November 16 and 17, because the peaks were indistinct, and the crater walls were invisible. No satisfactory reference points were therefore available. Drawings were secured every night through the lunation, but the appearance on November 20 was practically the same as that on the previous night, and the drawing of that date was therefore omitted.

The lunar colongitude for every day of the year is given in the Nautical Almanac, and corresponds to Greenwich Apparent Time for the Earth. Since the longitude of Eratosthenes is 11° E, the Sun rises on that crater at colongitude 11°, crosses its meridian at 101°, and sets at colongitude 191°. If we consider that the lunar day corresponds to the year on the Earth, then for this crater the vernal equinox occurs at colongitude 11°, the summer solstice at 101°, and the autumnal equinox at 191°. The latter comparison is perhaps the more appropriate in considering the growth of vegetation. The twelve drawings are oriented, as is customary, with south at the top and east at the right hand, but it must be remembered that by definition the terms east and west

are reversed on the Moon, so that the Sun there rises in the west, and sets in the east. Under each figure is recorded the date upon which it was drawn, the year being 1918, the corresponding colongitude, and the age of the Moon. The last of these quantities is of no use to the professional selenographer, since it merely shows the relative positions of the Earth and Moon with respect to the Sun, which is of no consequence whatever. It is given here, however, since it may be of assistance to the amateur. The age of the Moon is analogous to the colongitude, but varies appreciably from it.

Eratosthenes can readily be found by anyone who has even a slight knowledge of the lunar surface, since it lies 10° to the northwest of Copernicus, and on a small scale closely resembles that crater when the Sun first rises upon it. As the lunation progresses, however, Copernicus turns white, from the precipitated cloud and snow, while Eratosthenes turns dark, from the growth of the vegetation within and around it. Very soon they are quite unlike, and at full moon, while Copernicus is conspicuous, Eratosthenes can only be found by one who has carefully watched and drawn it night after night, and who knows just where to look for it. For three days at this time it is difficult to recognize, but after that it reappears, and remains conspicuous for the remainder of the lunation. Since it is situated in latitude 14° N, it is located near the center of the disk, and there is no trouble from libration. It is 37 miles (59 km.) in diameter, and its walls rise to an elevation of nearly three miles above the interior.

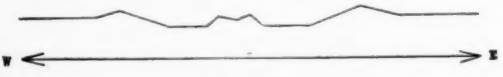


Figure 1.

Figure 1 gives an east and west section drawn to scale through the crater. From it we see that none of the slopes are very steep, indeed they are less so than we might expect to find upon the Earth. The steepest average slope of the inner wall is less than 20°. These walls therefore are only in full shadow before colongitude 31°, and after 171° as may been seen by the solid black in the drawings. They are deeply shaded, however, prior to 60°, and after 130°. Between 130° and 140° a good deal of the shading is only apparent, and is due to vegetation. The drawing of November 17, Figure 7, was made at 15^h G.M.T., which was only $4^h.5$ before full moon. It is obvious that none of the dark areas shown in that drawing can be due to either shadow or shade. That some of them were really very dark can be seen by a reference to the photographs, Figures 16 and 17.

These photographs show that large areas of vegetation surround the crater, particularly on the west and north, these areas being nearly invisible in Figure 14, taken soon after sunrise on the Moon. If the lunar vegetation has leaves, we must consider that only the twigs and

branches are visible near sunrise and sunset. Its form is of course quite unknown to us and the phenomena may consist merely in the darkening and fading of its exposed surface. As has been mentioned in previous articles, we assume the phenomena to be due to vegetation, because that explanation is plausible, and because none other of any sort has ever been offered for it. That clouds and snow occur upon the Moon, and that consequently it possesses at least a slight atmosphere has been shown in the papers on Meteorology of the Moon (POPULAR ASTRONOMY, 1915, **23**, 129), The Snow Peaks of Theophilus (POPULAR ASTRONOMY, 1917, **25**, 149), and elsewhere. There is therefore no reason why vegetation should not exist.

The lunar vegetation is not green. It is gray like our sage brush and some of our cacti, and black like our lichens,—almost a purplish black in some places, near the equator. The vegetation on Mars we know is also gray for most of the year. The lunar vegetation is scattered, generally in rather small patches over the surface. None is found near the poles. The only greenish spot located upon the Moon is the floor of the great crater Grimaldi, but even here the color is not marked. By far the greater part of the lunar surface appears to us to be simply a desert waste. The vegetation, where found, is often associated with minute craterlets, as in Alphonsus, the craterlet occurring at or near the center of the dark area. Sometimes it is associated with rills as in Atlas. In any case its growth and decline must necessarily be very rapid, the changes being most marked near the time of the crater's summer solstice. Consequently they always occur at a considerable distance from the terminator, or in a portion of the Moon which the amateur seldom examines with care. Near the terminator, on the other hand, few changes of interest occur other than the shifting shadows, which can hardly interest the professional selenographer.

Perhaps the most marked and therefore the most interesting change in Eratosthenes, as seen with a small telescope, occurs between colongitudes 60° and 72° (Figures 5 and 6), when the large dark spot is darkening on the floor northeast of the central peaks, and the regions immediately to the southeast of them are fading. From then until well after full moon changes on the southeastern crater walls are quite marked. There we can watch the gradual spread of vegetation as shown between Figures 6 and 10, and see it fade in Figure 11. If it were due to shadow it should continue to increase in 11 and 12. Again we can follow it as it gradually creeps over the northeastern wall in the drawings following Figure 5, and joins the large spot on the eastern crater floor in Figure 10, again fading in 11 and 12. The darkening of the western outer walls with the approach of noon is well shown by the drawings, and still better, as above mentioned, by the photographs.

To those interested in Mars, the formation and disappearance of the canals on the floor in the northwestern quadrant, shown in the

drawings Figures 3, 4, and 5, and later in Figures 10, 11, and 12 is suggestive. The two canals originate and diverge from a dark spot on the slopes of the central peaks. They then drop to the floor, cross it, ascend the 12,000 feet of the interior wall, and terminate in a dark area or field of vegetation upon the outer slopes. A comparison of the canals south of the crater represented in Figure 5 with the photograph Figure 15 is of interest, as showing how the eye may be deceived when the canals are faint and difficult, into drawing them as straight uniform lines. On the other hand when they were better developed, and darker, in Figure 8, the drawing more closely resembles Figure 17. Probably no canals either lunar or Martian, if well seen, would be perfectly uniform.

To the Martian observer the Moon appears as an ever changing scene of perennial attraction. While Mars possesses a very strong interest to us, based on the fact that it may support intelligent life, yet the very arguments that are adduced in support of this view might almost as well be applied to the Moon. In the case of the latter we cannot well believe that such life exists, because of the extreme rarity of its atmosphere, yet there is no more artificial looking formation apparent on Mars than the close double canal associated with the crater Aristillus. The two components of this canal stretch out straight, slightly divergent and perfectly uniform, side by side, for mile after mile. They originate in a small dark area on the inner wall and, after ascending the slope over an elevation of 4000 feet, descend, still as two narrow uniform canals, to a large field on the outer mare. The darker portion of the field covers about fifty square miles (130 square kilometers), and as we watch it gradually darkening, following the formation of the canals, it gives us irresistably the impression of being in some way watered by them. How such a thing could be, however, it is impossible for us to conceive, since we believe that no water can exist on the Moon, except such as is retained in its soil by capillary attraction.

At the same time snow certainly exists there, because we can watch certain extremely bright spots gradually diminish in area, and disappear in the sunlight. Indeed we apply to them precisely the same argument that we do in explanation of the polar caps of Mars. Since this melting does not take place very fast, evaporation at the freezing point cannot be very rapid. Around the central peaks and crater rims we can watch the water vapor condense into clouds, composed of minute particles of ice. These clouds sometimes change their places from one lunation to another, as in Eimmart and Theophilus, but there is no rapid shifting, or similar evidence of lunar winds. When the snow diminishes, no dark rim forms around it as in the case of Mars. The dark rim implies temporary lakes and marshes on the planet. The pressure of the lunar atmosphere therefore cannot much exceed 5 millimeters, the vapor density of water at 0°. The canals of Aristillus increase from 300 to 1500 feet in width as the lunation progresses, and reach a maximum length of 24 miles, or about eighty times their maxi-

Fig. 14 Mar. 28
16° 9d

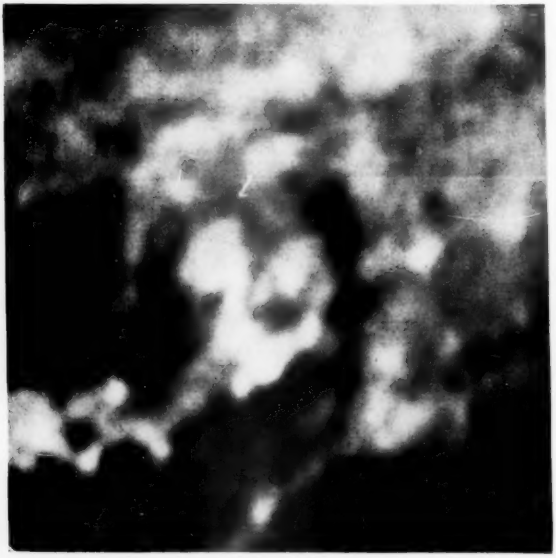


Fig. 15 Mar. 31
54° 12d

PHOTOGRAPHS OF THE LUNAR CRATER ERATOSTHENES

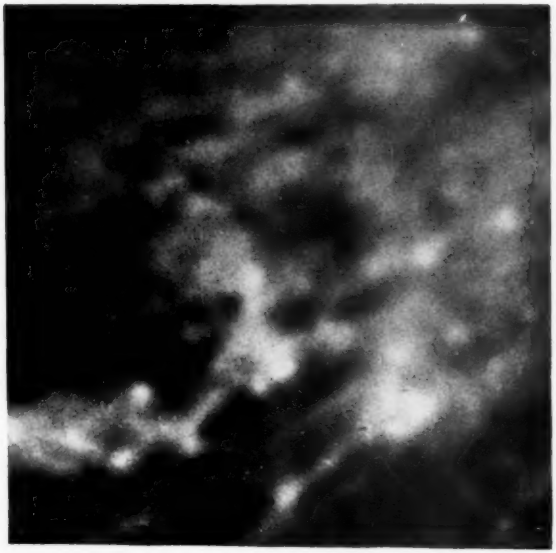


Fig. 16 Apr. 2
79° 14d

Fig. 17 Mar. 5
97° 15d

PHOTOGRAPHS OF THE LUNAR CRATER ERATOSTHENES

mum width. The first and most interesting eight or ten miles of their length have been drawn by four observers at three different observatories (POPULAR ASTRONOMY, 1914, **22**, 570; 1916, **24**, 77, 273, and 575). They are very difficult, however, and beyond the reach of the average amateur. Diverging double canals are also found on the northwestern inner slopes of Autolycus and Menelaus.

The point on which we wish to lay especial stress in this place, however, is this. It appears that the observer furnished with even a modest 3-inch telescope can see and study the details of the changing coarser lunar canals to better advantage than those furnished with much more powerful instruments can study the canals of Mars. The phenomena are similar, and any conclusions derived from the study of the Martian canals should apply to those of the Moon, and *vice versa*.

Mandeville, Jamaica, B.W.I., June 20, 1919.

THE ROMAN CALENDAR AND ITS REFORMATION BY JULIUS CAESAR.

ROSCOE LAMONT.

After Julius Caesar became the ruler of the Roman world, one of his most important and useful achievements was the reformation of the calendar. The ordinary year of the Romans, before the Julian reform, consisted of 355 days, distributed into twelve months as follows:

January	29 days	Quintilis (later named July)	31 days
February	28 days	Sextilis (later named August)	29 days
March	31 days	September	29 days
April	29 days	October	31 days
May	31 days	November	29 days
June	29 days	December	29 days

Since the solar or tropical year contains nearly 365¼ days, this twelve-month year was too short by 10¼ days, and to make the average length of the civil year agree with the tropical, additional days were inserted. An extra month, consisting alternately of 22 and 23 days, was to be intercalated every other year between the twenty-third and twenty-fourth of February. This increase of 45 days in four years was equivalent to 11¼ days a year, which added to 355 days gave 366¼ days as the mean value. This was one day too great, and to take away this excess a cycle of twenty-four years was employed. In twenty-four years the excess would be twenty-four days, and, therefore, in the last eight years of this cycle sixty-six days were to be intercalated instead of ninety. Thus in a period of twenty-four years the average length of the year was 365¼ days.

This was the scheme according to Censorinus and Macrobius, the two ancient writers who have given the most complete history of the Roman calendar, but the rules laid down were not followed, especially

in later times, for the calendar had fallen into such confusion that in the year 47 B.C., the year preceding the one in which Julius Caesar carried out his reform, the vernal equinox came on or about June fifth. The year of correction, 46 B.C., called by Macrobius the last year of confusion, consisted of fifteen months with 445 days, the intercalary month of 23 days being inserted in February, and two months of 67 days placed between November and December, which caused the equinox to come on March 23 or 24 in the year 45 B.C., the first year of the reformed calendar. If the equinox occurred on June 5 in 47 B.C., in the year 46 it fell on or about May 23, there being 365 days between these two dates by the old calendar, 23 days having been intercalated in February. From May 23 of the year 46 to March 24 of 45 there are 365 days, with 67 days placed between November and December, the number of days in the remainder of the year 46 being computed according to the unreformed calendar, and January in the year 45 having 31 days, the new calendar beginning with that month. This supposes that the year 45 was not a leap year, February having but 28 days.

According to the historian Mommsen the year began on March 1 until the reformed calendar went into effect, and if this was the case, the reason for inserting just 67 days between November and December in the year 46 may have been to make a complete year from March 1 to December 31, the addition of 67 days making the total exactly 365. The following year would then begin on January 1 at the time of the beginning of the reformed calendar. In this case the 445 days mentioned above would not all belong to one calendar year, but would all be included in one consular year, the consular year beginning January 1, Mommsen's view being that the consular and calendar years did not begin on the same date until after the Julian reform.* Considering that the calendar year began on March 1 before the reform, the consular year 47 contained 355 days and the calendar year 378 days, and the consular year 46 consisted of 445 days and the calendar year of 365 days.

Some writers consider that, as 67 days form three intercalary months, two of 22 days and one of 23, and as the intercalary month in the eighteen years before the reform had been omitted three times when it should have been inserted, 67 days, equal to three of these months, were added to the year 46 as a compensation for the previous omissions.

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*Censorinus says that the year in which he was writing was the 283rd of the Julian years, but dating from the calends of January which Julius Caesar made the beginning of the year established by him. This seems to intimate that before the Julian reform the year did not begin on January 1. Dio Cassius, an ancient historian who tells something about the Roman calendar, says that 67 days were added by Caesar as that was the number required to bring the year out even, which seems to mean, if it means anything, that with the addition of 67 days a complete year was formed, which would require the calendar year to have commenced on March 1.

In the Encyclopedia Britannica, in the article on the Calendar, the following statement is made:

"In the distribution of the days through the several months Caesar adopted a simpler and more commodious arrangement than that which has since prevailed. He had ordered that the first, third, fifth, seventh, ninth and eleventh months, that is, January, March, May, July, September and November, should have each thirty-one days, and the other months thirty, excepting February, which in common years should have only twenty-nine, but every fourth year thirty days. This order was interrupted to gratify the vanity of Augustus, by giving the month bearing his name as many days as July, which was named after the first Caesar. A day was accordingly taken from February and given to August; and in order that three months of thirty-one days might not come together, September and November were reduced to thirty days, and thirty-one given to October and December. For so frivolous a reason was the regulation of Caesar abandoned, and a capricious arrangement introduced, which it requires some attention to remember."

This statement has appeared in the Britannica for nearly a hundred years, being found in the article on the Calendar written by Thomas Galloway for the seventh edition published about 1830, and republished in all the succeeding editions, but according to the statements of Censorinus and Macrobius, who tell exactly what Julius Caesar did, there is no truth in it whatever. Many ancient Roman calendars have also been discovered which are shown in the Corpus of Latin Inscriptions. The earliest one, according to Mommsen, dates from the years 723-724 of Rome (31-30 B.C.), and the month following July has thirty-one days. This date was more than twenty years before the name Sextilis was changed to Augustus. While this early calendar is incomplete, containing only the last part of some of the months, from the names of the festivals placed opposite the days the months represented can be determined.

Censorinus, in his book "The Natal Day," written to celebrate the birthday of his friend Cerellius, after discussing a variety of subjects, such as the opinions of the ancient philosophers on the age of the human race, why twins are sometimes born, the distances of the stars, and the music of the spheres, gives a history of the Roman calendar, explaining the manner of making the civil and solar years correspond by means of the intercalary month, and speaks as follows of the confusion into which the calendar had fallen and of the reform of Caesar:

"The pontiffs were charged with making the intercalation, but most of them, on account of enmity or friendship, shortened or lengthened the term of a magistrate, and intercalating more or less according to their pleasure, caused a farmer of the revenue to gain or lose according to the length of the year, thus making worse what was given to them to correct. The disorder was so great that Caius Caesar, chief pontiff, in his third consulate and that of M. Aemilius Lepidus, corrected former abuses by placing two intercalary months of 67 days between November and December, although he had already intercalated 23 days in the month of February, thus giving to that year 445 days. At the same time, to prevent a like error from occurring in the future, he abandoned the intercalary month and regulated the civil year by the course of the sun, adding 10 days to the former 355, so distributed among the seven months having 29 days that two days were added to January, Sextilis and December and one to each of the others, and he placed these days at the ends of the months in order that the religious festi-

vals might remain in their former places. . . . . As to the quarter of a day which it seems completes the true year, he directed that one day be intercalated, after each period of four years, where the month was formerly placed, that is, after Terminalia (February 23rd), which is now called bissextile day. From this year, thus regulated by Julius Caesar, those down to our time are called Julian, and they began at the fourth consulate of Caesar."

Macrobius, in his work, "Saturnalia", after giving a long history of the Roman calendar, describes the Julian reform:

"Julius Caesar added ten days to the former number in order to complete the 365 days which the sun takes to pass through the zodiac; and to take account of the quarter of a day, he directed the pontiffs, who were entrusted with the months and days, to intercalate one day every four years in the same month and in the same place the ancients had intercalated, that is, before the last five days of February, hence this day was called bissextile. The ten days added were distributed in such a way that January, Sextilis and December received two days, April, June, September and November one only. He added nothing to February in order that the religious rites in honor of the gods of the nether world might not be changed. March, May, Quintilis and October remained as they were, their 31 days being a sufficient number, though they had their nones on the seventh as Numa had ordered, Caesar not having changed this arrangement. January, Sextilis and December, to which Caesar added two days, although after Caesar they began to have 31 days, still had their nones on the fifth, nineteen days being counted from the ides to the calends of the following month."

According to these extracts from the the writings of Censorinus and Macrobius, all the months, after the Julian reform, had the same number of days they have today, and the statements of Mr. Galloway in the Britannica are wholly in error. Statements similar to those in the Britannica are found in a work by John Brady, published in London in 1812, entitled, Clavis Calendaria or a Compendious Analysis of the Calendar, but it is probable that Mr. Galloway obtained his information from Sacro Bosco, an Englishman of the thirteenth century, who wrote a book called "De anni ratione", which he states was written in the year 1232, Mr. Galloway making a reference to this book. An edition of this work, which is in Latin, was published in Antwerp in 1551, and the part relating to the reform of the calendar by Julius Caesar is as follows:

"Julius Caesar distributed the days among the months so that the odd months had thirty-one days and the even ones thirty; but when he came to January, the last odd month, one day was lacking. He therefore subtracted one day from February to complete the number for January, which February recovered in the bissextile year.* Also in the time of Julius Caesar, the Romans, flattering him, gave the name Julius to the month which before was called Quintilis, because he was born in that time. Likewise in the time of Augustus the month which before was called Sextilis they named Augustus. But then Augustus, envious because his month was shorter than the month Julius, stole one day from February and added it to Augustus (August), hence February remained with 28 days. Another inconvenience resulted, three months of 31 days coming together, namely,

*His belief was that before the Julian reform the year, beginning with March, consisted of 354 days, the months having alternately 29 and 30 days; that eleven days were added by Caesar, two days being given to five of the months containing 29 days, beginning with March, and there being only one day left to give to January, in order to make up its number 31, February was reduced to 29 days.

July, August and September. He therefore took one day from September and assigned it to October, and likewise one day from November which he added to December. And this disposition of the months and arrangement of the number of days, which it will be allowed was reprehensible, the Church uses even today."

If a change such as he describes was really made, everybody no doubt would allow that it was reprehensible. What Mr. Galloway says it simply a good translation from Sacro Bosco's work, and the question is, where did Sacro Bosco get his information? He gives no authority for any of his statements, which are altogether different from anything the Roman writers say, and if he merely gave the arrangement he thought Julius Caesar ought to have made, as seems probable, with a theory as to how that arrangement came to be disturbed, his statements being given a wide circulation by the Britannica and reproduced in many other works on the calendar, there would seem to be a good deal of truth in the saying of Voltaire, that history is fable agreed upon.

In 1866 Lepsius discovered at Tanis, Egypt, a stone on which there was a long inscription in the Egyptian and the Greek language. This stone is known as the Tanis or Canopus stone, a cast of which is in the National Museum at Washington, and the inscription was found to contain a decree establishing a new calendar in Egypt in the year 238 B. C., a translation of this part of the writing, as made by Budge, being as follows:

"And in order that it may happen that that which hath been decreed to be done at each season of the year may be done in accordance with the position which the heavens have with reference to the things which have to be performed at the present time, so that occasion may not be given and the case may not arise that some of the festivals which are celebrated in Egypt in the winter should come to be observed in the summer, in consequence of the rising of Sirius advancing one day every four years, and on the other hand some of the festivals which are at the present time celebrated in the summer should come in the future to be celebrated in the winter, a thing which actually happened in the times which are past, and would happen at the present time if the year consisted of 360 days and the 5 days according to the directions for adding the additional days which have been observed: from this time onwards one day, a festival of the Good-doing Gods, shall be added every four years to the five additional days which come before the new year, so that it may happen that every man shall know that the small amount of time which was lacking in the arrangement of the seasons and of the year and in the things which passed as laws for the knowledge of their movements, hath been corrected, and that it hath been supplied by the Good-doing Gods."

This calendar is identical with the Julian, except as to the number of days in the months, and it required, therefore, no great skill on Caesar's part to establish the reformed Roman calendar, since one with the same length of the year and the same method of intercalation had been established in Egypt nearly two hundred years before, and cut on a stone seven feet high. Dio Cassius, in his History of Rome, says that "he got this improvement from his stay in Alexandria", and the astronomer Sosigenes, coming from Egypt, executed the work. This makes it somewhat amusing to read in Anthon's Classical Dictionary:

When we consider the imperfections of all mathematical instruments in the time of Caesar and the total want of telescopes, we cannot but view with admir-

ation, not unmixed with astonishment, that comprehensive genius which, in the infancy of science, could surmount such difficulties and arrange a system that experienced but a trifling derangement in the course of sixteen centuries."

Julius Caesar did not live to see that the calendar got safely started on its course, he having been assassinated in the year 44 B. C., and the pontiffs, through a misunderstanding or by design, made every third year a leap year instead of every fourth. This continued until there had been twelve leap years when there should have been but nine, and to make the proper correction Augustus ordered the omission of intercalations during the next twelve years, thus cancelling the former error.

It is stated by Dio Cassius that in the year 41 B. C., an extra day was added to prevent the market day, which occurred every eight days, from coming on the first day of the following year. The market or nundinal day came at the end of an eight-day week which ran on from one year to another the same as our seven-day week. For example, if the market day came on the next to the last day of the year, the first one in the following year would fall on the seventh of January. While the market day could thus come on any day of the year, it was thought to be a bad omen if it came on the first day of the year, and a day was sometimes added in order to prevent this. With every third year a leap year there is a three year cycle, and since the sum of 365, 365 and 366 is 1096, which is a multiple of 8, if in one such series of three years the market day does not fall on the first of January, then by continuing to make every third year a leap year it would never fall on the first of January, and some writers have maintained that the pontiffs intentionally made every third year a leap year in order to prevent the market day from falling on the first day of the year, Dio Cassius stating that a day was added for this reason only four years after the establishment of the Julian calendar. But it seems more reasonable to suppose that a mistake was made by the pontiffs, and that the extra day was added in the year 41 because of some disturbance which had occurred during the civil war. Caesar's order was, according to Macrobius, that every fourth year should be leap year, but since the Romans, in counting from one event to another in a series of years, included the year at the beginning as well as the one at the end, the direction to intercalate every fourth year might have been understood to mean what in our reckoning would be expressed by every third year.

There is a possibility, however, that every third year was made a leap year because of the market-day superstition. About the time Augustus made the correction in the method of intercalation he became Pontifex Maximus, the head of the College of Pontiffs which had entire charge of all matters pertaining to the calendar; the month Sextilis was named Augustus in his honor; on his birthday, September 23, which was celebrated as a holiday, he obtained the privilege of having a horse race perpetually (so Dio Cassius says), and he may have thought it time to

abandon a superstitious practice and regulate the calendar as his great-uncle Julius Caesar had directed.

There is a disagreement among writers on the Julian calendar as to which were the leap years during the time they were reckoned every third year, and also as to the years in which the intercalations were omitted by order of Augustus. Some hold that 45 B. C. was the first leap year, others the year 44, others 42. As to the year 41 a difficulty arises because of the extra day that Dio says was added so that the first day of the following year would not be the time for the farmers to go to town and cause some disaster to the state. Dio says that naturally a day would be subtracted later, but he apparently doesn't know whether it was or not, or if so in what year, and nobody else knows. There seems to be some confusion still, and it would have been well if Caesar had lived a few years longer to have taught the Romans that the excess quarter of a day would form a whole one by taking it four times instead of three, and that preventing the market day from coming on New Year's day was not of sufficient importance to justify tampering with the calendar.

Thirty years after the establishment of the Julian calendar a governor of Gaul, appointed by Augustus, made the year consist of fourteen months in places where the people paid taxes by the month. He told them that December was really the tenth month (decem, ten), and therefore it was necessary to add two more, which he called Undecimber and Duodecimber, and made them pay taxes for those two.*

There is no agreement among writers, either ancient or modern, as to the position of the extra day inserted in February in leap year. This day was called bissextus (twice-sixth), the sixth day before the calends or the first day of March being counted twice, and the question is whether the inserted day was to be considered as the one immediately after the twenty-third of February or the second one after the twenty-third. The Romans numbered the days as so many days preceding some date in the future, instead of so many days after a date in the past as we do, and it seems sensible to hold that the day called bissextus, twice-sixth or the second-sixth, followed the first-sixth, and that, therefore, the intercalary day was the second one after the twenty-third of February. This view is confirmed by an inscription of the year 168 A. D., which states that a temple was dedicated on the fifth of the calends of March of that year, which followed the bissextile day. This also seems to be in accordance with the decision of the Roman judges, quoted by Mommsen in his Roman Chronology, the decision being that the day posteriore was to be considered as the intercalary day, the two days which were named the sixth of the calends of March being called priore and posteriore. That the day inserted in February in leap year was the second one after the twenty-third is maintained by Mommsen, but other

*Dio Cassius, Book 54, Chapter 21.

writers of equal authority, as Ideler and Bouché Leclercq, dispute this and hold that the intercalary day immediately followed February 23, which agrees with the statements of Censorinus and Macrobius, and is also in accordance with old Church calendars.

A number of theories have been proposed to account for the name leap year, some holding that it is a misnomer, there being no leap made. The best explanation, and the one accepted by the modern dictionaries, is that given by Hearne in his Ductor Historicus or a Short System of Universal History, published in 1704, as follows:

> "That year was called bissextile, and by us leap year, because one day of the week is leaped over in the observation of the festivals by reason of the additional day in that year."

Since in a common year there are fifty-two weeks and one day and in leap year fifty-two weeks and two days, any fixed festival after February, which comes, say, on Monday in one year, and in the following year, if a common year, on Tuesday, will come in the next year, if one of 366 days, not on Wednesday but on Thursday, leaping over one day. For a festival in January and February the leap will be made in the year following the leap year.

The manner in which the Romans named the days of the month seems a little clumsy, and Delambre says it savors of ignorance and barbarism, but the method is easily understood and not difficult to use, and was employed by historians until the sixteenth and seventeenth centuries. There were three days in each month called the calends, nones and ides, and the days were reckoned according to the number of days preceding one of these. The ides were the fifteenth of March, May, July and October, and the thirteenth of the other months. The nones were eight days before the ides (nine days according to the Roman method of counting inclusively) and came on the seventh of March, May, July and October, and on the fifth of the other months. The first day of the month was called the calends. Between the calends and nones the day of the month was the number of days preceding the nones, between the nones and the ides, the number of days preceding the ides, and after the ides the date was the number of days before the calends of the following month, in each case the day *from* which the reckoning was made being included as well as the day *to* which it was made. The day following the calends of March was the sixth day before the nones, the day following the nones the eighth day before the ides, and the day following the ides the seventeenth day before the calends of April.

A method similar to this is sometimes used now. A few days before Christmas the papers print from day to day notices to shop early as it is only ten days before Christmas, nine days before Christmas, and so on. To Young America the almanac date July third is the day before the fourth. This was the Roman method (also used by some of the Greek states, each of which had a calendar of its own), to look forward

to some fixed date in the future and count the number of days preceding this fixed date, instead of looking backward to the first of the month as is done now and reckoning the date as the number of days after the first of the month.

In early times, when the lunar month was used, the calends was the day after the new moon was first seen in the heavens, the nones were supposed to be at the first quarter, and the ides at the full moon, and Macrobius describes the ancient custom of calling the people together as soon as the new moon was visible, when the pontiff announced the day on which the nones would occur. If the nones were on the fifth the Greek word kalo (I call) was repeated five times, and if on the seventh, was repeated seven times, and hence the day on which the announcement was made was named the calends and the place of assembling was called the Calabra. When the intercalary month was later employed to make the year correspond with the solar year, the calends, nones and ides continued to be used although they had no relation to the moon.

Plutarch, who was a Greek writer, says in his life of Numa that the intercalary month was called by the Romans Mercedinus, and in his life of Julius Caesar the form Mercedonius is used, but as this month is never given any such name by the Roman writers, it being called simply mensis intercalaris, the German writer Unger, in his work on the Roman calendar, considers that Plutarch's statement was based on a misunderstanding. Unger refers to a work by Lydus "On the Months," in which it is stated that November was called Mercedinus in ancient times, and he supposes that Plutarch confused the intercalary months placed after November in the year 46 B. C. with the month inserted in February. According to this view the year of confusion was the cause of still more confusion. Whether this is correct or not, and it seems quite improbable, some modern writers on the calendar think it a little strange, if the intercalary month was called Mercedonius by the Romans, that the Roman writers were not aware of it.

Macrobius makes the following statements with regard to changing the names of the months Quintilis and Sextilis to July and August:

> "Quintilis, by a law proposed by the consul Marcus Antonius, son of Marcus, was called Julius (July) in honor of the dictator Julius Caesar who was born the fourth of the ides of this month."
>
> "August, which was formerly called Sextilis, was afterwards named in honor of Augustus by a Decree of the Senate in the following words: Whereas the Emperor Augustus Caesar in the month of Sextilis was first admitted to the consulate and thrice entered the city in triumph, and in the same month the legions from the Janiculum placed themselves under his auspices, and in the same month Egypt was brought under the authority of the Roman people, and in the same month an end was brought to the civil wars, and whereas for these reasons the said month is and has been most fortunate to this empire, it is hereby decreed by the Senate that the said month shall be called Augustus."

Julius Caesar and Augustus having been honored by giving their names to two of the months, other emperors desired the same honor.

Suetonius says that the Emperor Nero called the month of April Neroneus, and that Caligula called September Germanicus in honor of his father. It is a good thing these names did not stick. Just imagine anyone having to say:

Thirty days hath Germanicus,
June, November and Neroneus.

At a later time the Emperor Charlemagne, wishing to Germanize everything, changed the names of all the months, his biographer Einhard saying that he wanted names in his own language instead of the barbarous Latin names formerly used, calling January, Wintarmanoth; February, Hornung; March, Lentzinmanoth; April, Ostarmanoth; May, Winnemanoth; June, Brachmanoth; July, Heuvimanoth; August, Aranmanoth; September, Witumanoth; October, Windumemanoth; November, Herbistmanoth; December, Heilagmanoth.

In speaking of the origin of the names of the days and their use by the Romans Dio Cassius says:

"The custom of referring the days to the seven stars called planets was established by the Egyptians, but has spread to all men, though it was instituted comparatively not long ago. At any rate the original Greeks in no case understood it so far as I am aware. But since it has become quite habitual to all the rest of mankind and to the Romans themselves, and is to them already in a way a hereditary possession, I wish to make a few brief statements about it, telling how and in what way it has been so arranged. I have heard two accounts, in general not difficult of comprehension and containing some one's theories. If one apply the so-called principle of the tetrachord, which is believed to constitute the basis of music, in order to these stars by which the whole universe of heaven is divided into regular intervals, as each one of them revolves, and beginning at the outer orbit assigned to Saturn, then omitting the next two, name the master of the fourth, and after passing over two others reach the seventh, and in the return cycle approach them and the presiding gods in this same way, calling them by the names of the days, one will find all the days to be in a kind of musical connection with the arrangement of the heavens. This is one of the accounts."

To show clearly what Dio means, in column (1) below the seven planets of the ancient astronomy are arranged in the order of their distances from the earth, beginning with Saturn, the outermost one. In column (2), opposite each planet, is placed the day which was consecrated to the planet, using the English names, and in column (3) the days in the order in which we know them. Column (4) gives the Latin names in the order of column (3).

(1)	(2)	(3)	(4)
Saturn	Saturday	Saturday	dies Saturni
Jupiter	Thursday	Sunday	dies Solis
Mars	Tuesday	Monday	dies Lunae
Sun	Sunday	Tuesday	dies Marti
Venus	Friday	Wednesday	dies Mercurii
Mercury	Wednesday	Thursday	dies Jovis
Moon	Monday	Friday	dies Veneris

Having given in column (1) the planets in the order of their distance from the earth, and in column (2) the days of the week in the order corresponding, the problem is to discover how the days came to be arranged in the order given in column (3).

The word tetrachord means four chords. Starting with Saturn, opposite which is Saturday, pass over two planets and the fourth one is the sun opposite which is Sunday; by omitting two more we come to the moon opposite which is Monday; by skipping the next two (going back to the beginning) we come to Mars opposite which is Tuesday, and by continuing in this way come successively to the planets opposite which are Wednesday, Thursday and Friday.

Dio continues:

> The other account is as follows: If you begin at the first one to count the hours of the day and of the night, assigning the first to Saturn, the next to Jupiter, the third to Mars, the fourth to the Sun, the fifth to Venus, the sixth to Mercury and the seventh to the moon, and then repeat the process covering these twenty-four hours, you will find that the first hour of the following day comes to the Sun. And if you carry on the operation throughout the next twenty-four hours by the same method as outlined above, you will consecrate the first hour of the third day to the moon, and if you proceed similarly through the rest, each day will receive the god that pertains to it. This then is the tradition."

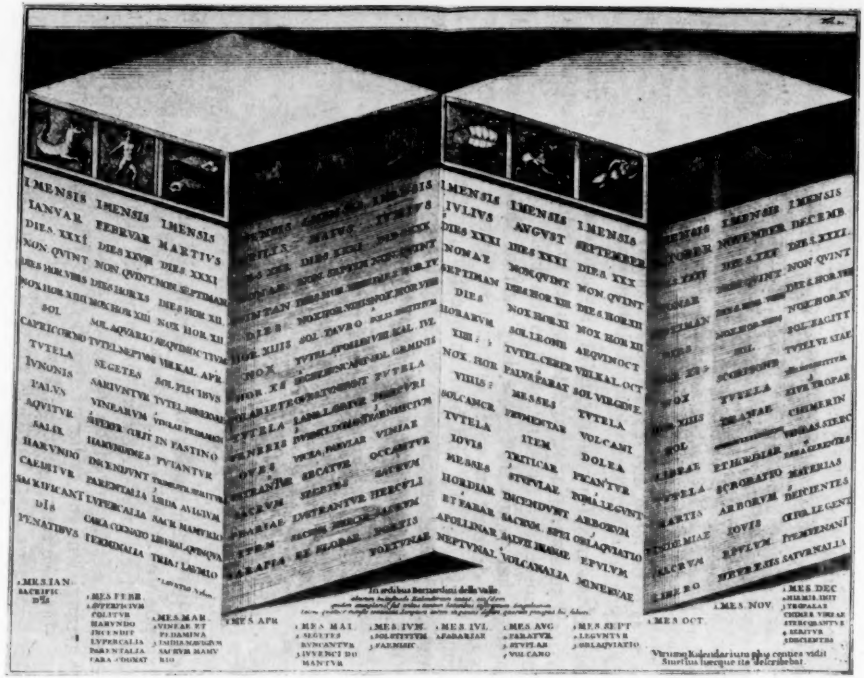
There are twenty-four hours in the day and each hour of the day is consecrated to some planet, and the planet to which the first hour of the day is consecrated gives its name to the day.

Dio says that in his time (the fore part of the third century) the names of the days in the order given above were a hereditary possession, and they probably had been in use for two hundred years. In July 1901, in making excavations in Pompeii (destroyed in 79 A. D.), there was found written on a wall in one of the houses the following names:

SATURNI
SOLIS
LUNAE
MARTI
JOVIS
VENERIS

These are the Latin names of the days in the order now in use, with the exception of Mercurii (Wednesday), which was doubtless left out through inadvertence. Among the pictures found at Herculaneum there is one of the seven dieties who presided over the days of the week arranged in the order of the days as follows: Saturn, Apollo, Diana, Mars, Mercury, Jupiter, Venus.

Macrobius says that Augustus ordered the correct rule of intercalation to be cut on a table of brass that it might be observed perpetually. It was the custom among the Romans to cut calendars on stone and place them at the crossroads, informing the husbandmen not only of the time to shear their sheep and pick their apples, but of their religious duties as well. An interesting calendar of this kind, discovered about the year 1550, is now in the National Museum at Naples. A picture of this calendar may be seen in most books on classical antiquities, but the one here shown was taken from Graevius' Thesaurus of Roman An-


IMENSIS IANVAR. DIES XXXI NON. QVINT DIES HOR. VIIII NOX HOR. XIIII SOL CAPRICORNO TVTELA IVNONIS PALVS AQVITVE SALIS HARVNDO CAELESTVE SIGNIFICANT DIS PENATIBVS
IMENSIS FEBRVAR DIES XXVIII NON. QVINT DIES HOR. IX NOX HOR. XIII SOL AQVARIO TVTELA SEGETES NARIVNTVE VINEARVM SITIENT CRET IN FASTINO HARVNDINES PVIANTVR DISCENDVNT PARENTALIA LVPERCALIA PARENTALIA CARA COGNATIO FERONIALIA
IMENSIS MARTIVS DIES. XXXI NON. SEPTIMAN. NOX HOR. XII SOL PISCIBVS VINEAE PRIMAE TVTELA VIRGAE VITIS SOLSTITIVM EQVORVM AVGVSTALIA TRIA LAMBO
IMENSIS IVLIVS DIES XXXI NONAE SEPTIMAN DIES HORARVM XIII NOX HOR. VIIII SOLCANCR. TVTELA IOVIS MESSES HORDIAR. ET FABAR. APOLLINAR. NEPTVNAL.
IMENSIS AVGVST DIES XXXI NON. QVINT. DIES HOR. XII NOX HOR. XII SOL LEONE TVTEL. CERER. FALVI FARAT MESSES FERMENTAR ITEM TRITICAR. STVVLAE INCENDVNT SACROS. EPVL. VOLCANALIA
IMENSIS SEPTEMBER DIES. XXX NON. QVINT DIES HOR. XII NOX HOR XII AEQVINOCT VELKAL. OCT SOL VIRGINE TVTELA VOLCANI DOLEA PICANTVR POMA LEGVNT ARBORVM SACROS. EPVL OBLAQVIATIO EPVLVM MINERVAE
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IMENSIS DECEMB. DIES. XXXI NON. QVINT DIES HOR. VIII NOX HOR. IV SOL CAPRICORNI TVTELVE SIAE SIVE TROPAEA CIMMERIN VIRGAS SIERC DESIGNATVRS MATERIAS DECIDENTES CERA. LE GENT IVPPENIANI SATVRNALIA
In ædibus Bertaredi della valle
Virumq; Kalendarium plus centies vidit
Sturtius hocque ita delineabat.
AN ANCIENT CALENDAR.

tiquities, published in 1698. The small figures above some of the words do not belong to the calendar, but refer to words placed below, of a different form, that are found on other similar calendars which have been discovered. A picture of one on which these variations occur is given in Gruter's Roman Inscriptions, the form of the calendar being a prism with four months on each face.

It will be seen that a great deal of astronomical, agricultural and religious information is furnished the farmer. The name of the month is first given, then the number of days in the month, the position of the nones (the ides being always eight days after the nones it was not necessary to speak of the ides), the number of hours in the day and night, the position of the equinoxes and solstices, the sign of the zodiac in which the sun was to be found, the god under whose protection the month was placed, the labors that were to be performed during the month, and the religious festivals which occurred in the month. Take the month of May: It has thirty-one days, the nones are on the seventh, the day consists of fourteen and one-half hours, the night of nine and one-half hours (the S stands for semis, half), the sun is in the sign of Taurus, the month is under the protection of Apollo, the corn is weeded, the sheep are sheared, the wool is washed, the steers are broken in, the vetch is cut for fodder, the corn fields are purified, sacrifices are made to Mercury and Flora.

A Farm Journal, a Church paper, and a modern almanac in one.

DESIGN OF A STELLAR PHOTOMETER.

G. A. SHOOK.

In the design of a stellar photometer, to be used on an equatorial, there are three things to be considered:—an artificial star of constant intensity, a means of bringing the image of this star into the field of view of the telescope, and a method for varying the intensity of the standard star in a continuous and determinate manner. The difference in color is, to be sure, a disturbing factor and in precise work the color of the standard star should be very near the same as that of the real star.

A simple method for varying the intensity of the standard star is by means of a neutral tint wedge such as is made by the Eastman Kodak Co. These wedges are furnished in various transmission ranges from 1 to 1/2 down to 1 to 1/10000. A wedge with a range of 1 to 1/100 would enable one to compare stars of the first magnitude down to the sixth magnitude. A greater range is obtained if we vary both the real and the standard star. For the brighter stars an absorption screen might be used to cut down the light from the real star and the balance could be made with the wedge.

The simplest method of varying simultaneously the real and the standard star is by the use of three Nicol prisms. Although it is more expensive, it is not more difficult to construct.

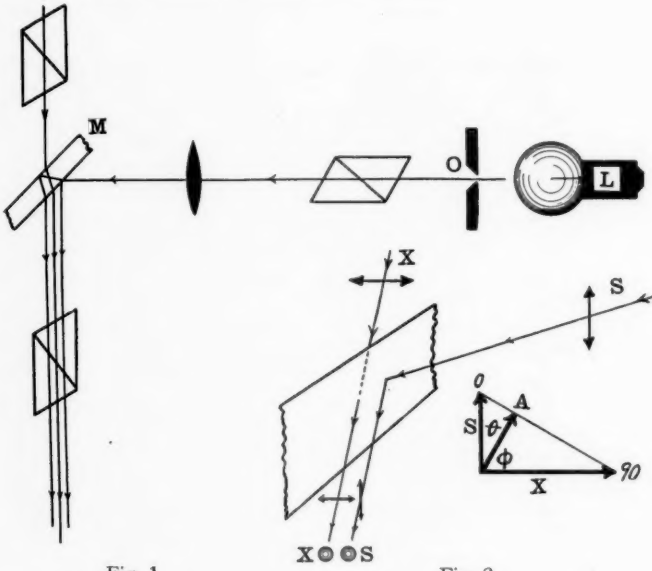


Fig. 1

Fig. 2

The optical system used by the writer is shown in Fig. 1. The standard star consists of a circular aperture *O* illumined by a miniature incandescent lamp *L*. A piece of ground glass or tracing cloth should be placed between the aperture and the lamp to diffuse the light. Light from *O* passes first through a Nicol and then through a lens which produces an image of the aperture *O* in the focal plane of the telescope. This beam is reflected from the front and rear surfaces of a piece of glass *M* as shown. (A microscope slide will answer for the mirror). Light from the real star passes through a similar Nicol, thence through the mirror, and finally forms an image of the real star in the focal plane of the telescope in the usual manner. We may from now on consider only one of the standard star images. The Nicols must be so adjusted that the light from the standard star *S*, Fig. 2, vibrates in the plane of the mirror while that from the real star *X* vibrates at right angles to this plane. A third Nicol between the star images and the eye may now be so rotated that all the light from *X* will be excluded, or all that from *S*; or it may be so adjusted as to produce equality of brightness in the star images.

If now we let *A* be the amplitude of vibration of the transmitted

light, S that of the standard star, X that of the real star, and θ the angle between A and S, then we may write

$$\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{A/X}{A/S} = \frac{S}{X}.$$

If the corresponding intensities are I_x and I_s then since the intensity varies as the square of the amplitude

$$\tan^2\theta = \frac{S^2}{X^2} = \frac{I_s}{I_x}$$

or

$$I_x = \frac{I_s}{\tan^2\theta} = I_s\cot^2\theta.$$

If it is more convenient to measure ϕ then

$$I_x = I_s\tan^2\phi.$$

If two stars, 1 and 2, are examined the ratio of their intensities becomes

$$\frac{I_1}{I_2} = \frac{\cot^2\theta_1}{\cot^2\theta_2}.$$

In terms of "difference in magnitude" Δm

$$\frac{I_1}{I_2} = 2.512^{\Delta m} \quad \text{or} \quad \log\frac{I_1}{I_2} = 0.4\,\Delta m.$$

Whence

$$\Delta m = 2.5\log\frac{I_1}{I_2} = 2.5\log\frac{\cot^2\theta_1}{\cot^2\theta_2}$$

or

$$\Delta m = 5\,(\log\cot\theta_1 - \log\cot\theta_2).$$

The Nicol in the path of the real star may be omitted but the scale of magnitudes is not nearly so uniform and the range is not so great. Moreover for the brightest stars a better balance is obtained when their intensity is somewhat cut down.

Consider the case when the intensity of the standard star alone is varied. The intensity of the real star in terms of the standard star is, from Fig. 2,

$$I_x = I_s\cos^2\theta \quad \text{or} \quad \frac{I_s}{I_x} = \sec^2\theta$$

whence

$$\Delta m = 5\log\sec\theta.$$

Let us suppose that the standard star is equal in intensity to a first magnitude star. Then if we substitute for Δm the values 1, 2, 3, ... we can calculate the value of θ corresponding to a 2d, 3d, 4th ... magnitude star.

When three Nicols are used we have that

$$I_x = I_s \cot^2\theta \quad \text{or} \quad \frac{I_s}{I_x} = \tan^2\theta .$$

The difference in magnitude is given by

$$\Delta m = 5 \log \tan \theta .$$

In this case let us assume that the standard star is equal in intensity to a 3d magnitude star. The difference in magnitude between the standard and a 4th, 5th, and 6th magnitude star is 1, 2, and 3; and the difference for a 2d and 1st magnitude star is — 1 and — 2. Substituting these values for Δm the corresponding values of θ may be computed. The following table shows the advantage in using the three Nicols.

Diff in mag. Δm	Magnitude	θ	Diff. in mag. Δm	Magnitude	θ
		°			°
0	1	0.	—2	1	21.7
1	2	50.9	—1	2	32.2
2	3	66.5	0	3	45.0
3	4	75.5	+1	4	57.8
4	5	80.9	+2	5	68.3
5	6	84.3	+3	6	75.9

The advantage of this particular design is that the photometer can be made almost entirely of standard telescope tubing. This tubing can probably be obtained from any large hardware store. In Boston it may be purchased from Chandler and Farquhar. Each size is practically 1/16″ greater in diameter than the preceding size, *i. e.*, the wall of the tube is about 1/32″ thick.

The tube *A*, Fig. 3, must be the same size as the eyepiece tube, so that when the latter is removed *A* will take its place. This depends, of course, upon the observer's telescope, and no dimension can be given. In the writer's instrument the innermost tubes such as *B* and *C* are 1″ outside diameter and they fit into the next larger size *D* which in turn fits the tube *E*. *D* can be rigidly clamped to *E* by means of the clamp shown, which is simply a brass hose coupling. A collar on *D* allows one to remove and replace the tube without changing the distance from the diaphram *O* to the lens *L*. *D* may also be turned, to adjust the plane of vibration of the standard light, without affecting the focus. When one tube is soldered to another it is indicated by *S*. The arrangement of the tubes shown in Fig. 3 will permit the various optical parts to be adjusted independently which is an important point to consider.

The aperture *O* was made as follows:

A thin piece of sheet brass was soldered over one end of a 1″ tube ⅜″ long and in this end piece a very small hole was made with a sharp needle. The best size can most readily be determined by experiment. If the hole is made too large it is more convenient to make other apertures in separate pieces of brass and to attach the proper one to this

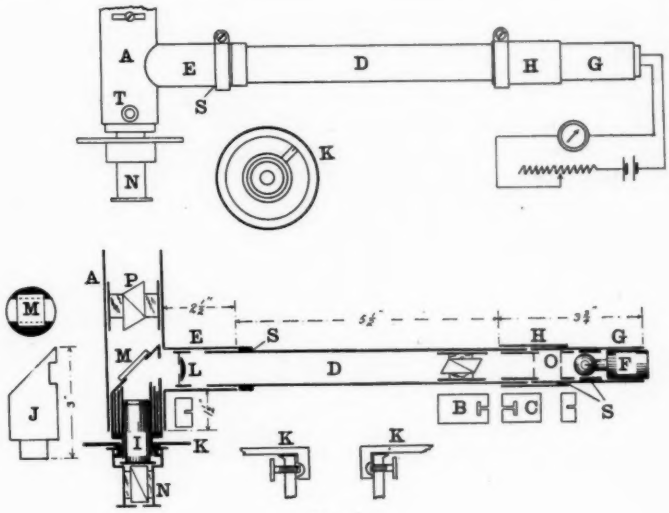


FIG. 3

tube with soft wax. It should finally be well blackened with camphor soot. A tube of the same diameter about ½″ long was soldered in tube *G* about ⅞″ from the end and this allows the lamp tube *F* to be inserted without any danger of breaking the bulb. A small brass lamp socket, such as is sold by dealers in electric toys, soldered in a piece of the 1″ tubing ⅞″ long, completes the lamp tube *F*. The tube *H* which is soldered to *G*, and which fits over *D*, is also provided with a brass clamp as shown. When *H* is removed from *D* one has access to the aperture *O* and the color screen tube *C*, and when the latter is removed the Nicol tube *B* can be removed.

When *D* is removed from *E* the lens tube can be withdrawn, or it may be moved in or out to produce a clear image of *O*. It is thus seen that from the lamp to the mirror any of the optical parts may be easily adjusted.

Let us now consider the tube *J* containing the 45° mirror. This was built up of several tubes, one fitting inside the other. The innermost tube is also 1″ outside diameter as this will just take a standard microscope eyepiece *I*. The writer uses a 5X. A convenient form of analyzer is the sort used on microscopes. The circle *K*, of such an analyzer may be attached directly to the inner tube. The eyepiece may then be inserted. The Nicol tube fits over the eyepiece but in some types of analyzers there is no arrangement for holding the Nicol tube in place, in which case a groove may be turned in the plate *K* and then the Nicol tube *N* may be held in place by means of two set screws as shown.

This the writer had done by a mechanician, but it was the only thing that cannot be made without machinery.

A less expensive analyzer was also constructed by the writer, out of telescope tubing, in the manner shown in Fig. 4. Tube *A* is held in place by pressure and when it is removed from *B* the eyepiece may be inserted. The index hand prevents the Nicol tube from working inward and must, of course, be soldered to the Nicol tube after the latter is in place. The scale is a brass protractor.

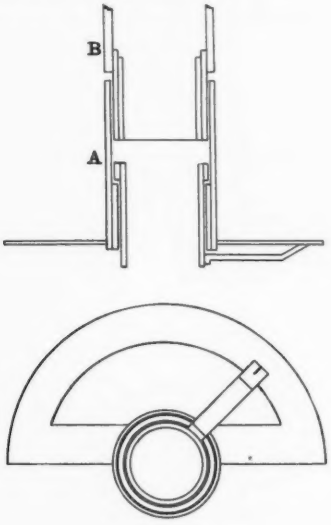


FIG. 4

The other end of tube *J* was cut off at an angle of 45° and two strips of brass were soldered to it as indicated. A clear piece of glass (microscope slide) was fastened to these strips with soft wax. The soft wax permits one to adjust the mirror and this adjustment must be carefully made or the images of the standard star will not appear in the field of view. The light from the lamp reaches the mirror through a square aperture in one side of *J*. *J* is held in place by means of a set screw *T*. This arrangement of the mirror allows one to rotate it, move it in or out, or withdraw it by simply loosening the set screw *T*.

The lens *L* is a simple lens with a focal length of 2½″ and such a lens may be obtained from any optical company.

The second polarizing Nicol *P* is mounted in a tube which fits *A* and is held in place and adjusted by means of a set screw as shown. The Nicol is set in the tube so that its vibrating plane is nearly at right angles to the plane of the mirror, and the fine adjustment is made by means of the set screw.

The Nicols need not have a clear aperture of more than 5mm. The simplest way to mount a Nicol is by mean of a split cork and a little soft wax.

The lamp is of the type used in flash lights. A 2.9 volt lamp is large enough, and if run on two large dry cells it will remain constant for nearly half an hour.

The circle of the analyzer should be so adjusted that when the index hand stands at 0 the light entering the tube *A* is extinct. It should moreover read 90 when the light from the lamp is extinct. To obtain this condition the polarizer for the standard star must be adjusted.

After these adjustments are made they should, of course, be tested by a large number of observations.

Greater accuracy will obtain if the analyzer is read in all of the four possible positions that it may take for any one balance. Suppose the analyzer reads 30 when the telescope is directed toward a particular star, a balance will also obtain if the analyzer is turned to 150, 210, and 330, provided all the adjustments are perfect. The average of all four readings for any particular case will of course give the best result.

Wheaton College, Norton, Mass.

THE INTERNATIONAL ASTRONOMICAL UNION.

JOEL STEBBINS.

As indicated in the May number of POPULAR ASTRONOMY, the conconference for the formation of the new International Astronomical Union was held in Brussels beginning July 18, 1919. The readers of this journal will probably be interested in the conference and particularly in the activities of the American Section of the Union, and of the American delegation. After the organizing meeting of the Section in March, the committees then appointed duly went to work, mostly by correspondence, and prepared reports which would be the basis of instructions on scientific matters to the American delegates. The Section met in Washington on June 23, about twenty astronomers being present, and spent two days in going over the reports, changing them in various details. Those of us who were privileged to be present at that meeting of the Section found it to be one of the most interesting and instructive scientific conferences we had ever attended. As the members of each committee had been appointed because of their present work in their respective fields, each report was more or less a summary of current activity in this country in different lines, and the reports taken together gave a very good idea of the various problems which are engaging the attention of astronomers. Although the emphasis was laid on those features of work which are adaptable to international coöperation, it was evident that astronomy knows no state boundaries, and that it is next to impossible for any investigator to work without

reference to what is going on in the same line somewhere else in the world. One feature which was brought out strongly was the great advantage of having technical reports discussed by a gathering of astronomers who are working in diversified fields. Apart from the educational value to all of us in knowing about work in other problems than our own, it was striking to note how some problem in meridian astronomy or even celestial mechanics would be related to stellar spectroscopy or some other phase of modern astrophysics. These various committee reports are of permanent value, and will be published by the National Research Council.

One-half day in Washington was given over to a joint meeting with the American Section of the International Geophysical Union, which was holding its organization meeting at that time. As there is no national "geophysical" society in America, the Research Council had brought together men from the different earth sciences such as meteorology, geodesy, terrestrial magnetism, etc., and it was proposed to send delegates to Brussels for American representation at the Geophysical Union. The astronomers and geophysicists have various fields in common, such as the variation of latitude for which there was appointed a joint committee from the two sections.

On the conclusion of the Washington meeting the delegates went to New York, from whence they sailed on the S. S. Aquitania on June 30. The personnel of the delegation consisted of Director W. W. Campbell of the Lick Observatory, who was chairman of both the astronomical delegation and the delegation to the International Research Council; Messrs. W. S. Adams, F. H. Seares and C. E. St. John of the Mt. Wilson Observatory; Benjamin Boss of the Dudley Observatory, Albany; S. A. Mitchell of the McCormick Observatory, University of Virginia; Frank Schlesinger of the Allegheny Observatory; and Joel Stebbins of University of Illinois Observatory. The party was honored by the company of two ladies, Mrs. W. W. Campbell and Mrs. C. E. Mendenhall, the wife of the scientific attache of the American Embassy in London. There were also on board two of the American delegates to the International Chemical Union, Messrs. E. W. Washburn and C. L. Parsons.

With a week before us on a large steady boat, there was some thought that it would be well to limit the talking of shop to a certain number of hours per day, but with other common interests in the standard forms of amusement aboard ship this was found unnecessary. It was an interesting commentary on the dimensions of our country that some of the delegates had never previously met, and others had last been together not in America but in Europe at the Bonn and Hamburg meetings of 1913. The members took the opportunity to have daily meetings to consider the matters of the approaching conference, and if the American delegation was not prepared it was not because we did not talk things over beforehand.

The voyage passed all too quickly, and on schedule time we arrived at

ASTRONOMICAL DELEGATES ON BOARD THE AQUITANIA.

Left to right, sitting—Boss, Mrs. Campbell, Mrs. Mendenhall. Standing—Schlesinger, Adams, Campbell, Mitchell, Seares, Stebbins, St. John.

Southampton, where we were met by Dr. Mendenhall who had thoughtfully looked out for our travelling arrangements, including reservations in the crowded hotels of London. On arrival at the metropolis we were delighted to be met in person by the Astronomer Royal, Sir F. W. Dyson, who had come to welcome us, and to give us all invitations to visit Greenwich the following day. Our English friends had also secured for us honorary membership in the Athenaeum Club, so that between this center and the rooms of the Royal Astronomical Society in Burlington House we felt much at home right in the heart of London.

At Greenwich the next day our hosts must have wondered at American ways when at the appointed time only one or two of the delegation had arrived. The others for safety had banded together in two parties, with expert guides; one crowd missed the train from Charing Cross, using a timetable for the wrong day (a common blunder by beginning students of practical astronomy), while the others proceeded to get lost between Picadilly Circus and Oxford Circus (the computed azimuth was in the wrong quadrant). However, we all finally arrived, and were cordially received by the Astronomer Royal and Lady Dyson, and the members of the Royal Observatory staff. Luncheon was served in the Octagonal Room, which dates from the time of Flamesteed, and it was an impressive experience for us to chat with the present day astron-

omers whose names we so often see in print, while on the walls of the room were the portraits of the different Astronomers Royal who also seemed like old friends.

Our party had a splendid opportunity to inspect the equipment and work at Greenwich under the guidance of the staff, and few of us neglected to observe the prime meridian and to stand with one foot in the eastern and one in the western hemisphere. We were particularly interested to learn how Greenwich had fared in the air raids during the war, and were shown a section of an unexploded bomb which had fallen nearby in the park, and also were told of some incendiary projectiles which fell inside the observatory enclosure without doing any damage. To balance the account, three brilliant meteors in the shape of flaming Zeppelins had been observed during the period of hostilities.

The next expedition during our stay in England was to the laboratory of Professor Fowler at South Kensington. Here we saw at first hand the factory where imitation comets and stars are being produced. Also in the museum nearby some of us saw for the first time a number of historic instruments, and some admirable educational models and exhibits, which included the latest views of the 100-inch at Mt. Wilson.

Soon after our arrival in London we had received the announcement of a special meeting of the Royal Astronomical Society which was to be held in our honor on July 11. This was an eventful day, and we began early to meet some of our old friends who came up to town in the morning. In the afternoon we were privileged to meet with a group of British astronomers, mathematicians and physicists for a conference on the matters which were to come up in Brussels. The meeting was of course entirely informal, the object being to talk over the proposals which had already been made in regard to the International Research Council and the Astronomical Union, to exchange points of view, for us to learn what they knew of the ideas of the continental astronomers and other men of science. This meeting at the Royal Society lasted for a couple of hours, and we then adjourned across the court of Burlington House to the "R. A. S."

Americans know of the meetings of the Royal Astronomical Society through the vivid accounts which are given in the *Observatory*, and we have learned to envy the astronomers of the little island who can get together once a month instead of once a year as we do. The meetings are preceded by a half hour for tea, are called to order at five o'clock and close promptly at seven. Having had much experience with meetings, the members do not put each other to sleep by reading from manuscript, but "talk" their papers. At this special meeting the particular disadvantage to us Americans was that we were destined to fill out the entire program, which was perhaps what our hosts wanted, but was rather hard on the guests, although we certainly could not have asked for a more attentive and appreciative audience. Each of our delegation gave a brief account of the work in which he is engaged.

After the meeting we were the guests of another important organization, the Royal Astronomical Society Club, which meets for dinner immediately following each session of the Society. The Club on this occasion broke a precedent of many years by inviting the two ladies of our party. Of English hospitality is is superfluous to speak, the only drawback being that our kind friends appeared not to have been sufficiently bored with our scientific accounts, and insisted that every one of us tell them something more in lighter vein. Those of us with insatiable and morbid curiosity about the effects of the war were able to discover that the room over the banquet chamber had on one occasion been visited by a bomb, and the result was still visible in the form of temporary electric wiring about the building.

For the week end following the meeting and dinner some of the party were taken in charge by Professor and Mrs. Newall at Cambridge, and others were glad to accept the kind invitation of the owner of the "Oxford Note-Book" for a stay at New College. Those of us who went to Oxford and were housed in rooms in the College could imagine that we were English students, and were quite willing to continue that sort of life for a time. Among the entertaining features which Mr. and Mrs. Turner arranged for us was a river trip, and each tried his hand at "punting" on the Cherwell (we also learned the pronunciation of the name of the stream), which was followed by tea on the bank with a beautiful landscape for a setting. We returned in time for dinner at New College—a great treat. Of course we got in some

GROUP ON STATION PLATFORM AT OSTEND.

Left to right—Schlesinger, Newall, Dyson, Mrs. Campbell, Campbell, Mitchell, Fowler.

time to visit the Observatory and to see where a zone of the Astrographic Chart was carried through to prompt completion.

In London we had some time for sight seeing, and on the day before the opening of the conference at Brussels most of the English and American delegates were assembled for the early morning train from Charing Cross. The trip to Dover was just as we knew it before the war, but on crossing the Channel we were interested to note that the boat headed straight across to Calais and then hugged the shore all the way to Ostend so as to avoid stray mines. Some of the party were much concerned over the prospective loss to science in case of shipwreck, but nothing came of their fears. The first glimpse of the war devastation was in the neighborhood of Nieuport and at Middlekerke, where what at first looked like buildings standing intact were found to be only the walls. At Ostend the railway station had been severely damaged, but was still usable, and our party was soon on a good train headed for Brussels.

It was encouraging to see from the car window how well the rich land is being cultivated, and how much repair work is going on about the numerous damaged bridges along the railway. Whatever wrong conclusions a casual chance observer will make about a country, we were promptly convinced that the trials the Belgian people have been through during five years have not prevented them from working heroicly at the problems of reconstruction.

On our arrival at Brussels among others who were at the station was Mr. Georges Van Biesbroeck who had returned to Belgium to arrange for his permanent transfer to the Yerkes Observatory. The next day our force was also strengthened by the addition of Major Philip Fox, who was soon to return home with his unit of the American army. The delegates were all housed in the Grand Hotel Brittanique, which was only five minutes walk from the Palais des Academies, where the sessions of the conference were to be held. After reading for some years of the scarcity of food and of the consequent cost of living, we were agreeably surprised at the fare and prices we secured. Of course there were evidences of the war, but as our last experiences at home had been in Washington and New York hotels, the accommodations in Brussels were quite acceptable.

On Friday, July 18, between one and two hundred delegates from the various countries assembled at the Palais des Academies for the first session of the International Research Council. We found numerous old friends among the astronomers, whom we had last seen at the international meetings of 1913. The meeting was to be opened in the presence of King Albert, and we Americans at least were in a state of expectancy until he should arrive. Finally as we were waiting in the assembly chamber there came the announcement: "Le Roi," and the tall figure in simple military uniform stepped into the royal box at one side of the hall. The meeting was then called to order, and the usual pre-

PLATE XLVIII

M. Benjamin Baillaud, Director of the Paris Observatory

The first President of the International Astronomical Union.

PALAIS DES ACADEMIES
Where the meetings were held in Brussels.

liminaries were gone through with. Seated at tables at each side of the presiding officer were the members of the Executive Committee of th International Research Council, and other notables. Some of us recognized only Professor Schuster, who is the Secretary of the Council, and our own Dr. Campbell. As the speakers read in French rapidly from prepared manuscript, those of us with moderate liguistic ability missed much in each speech, and it was only gradually that we learned who the different men were. After about an hour there was a recess, and the King withdrew without having favored us with some words, much to our disappointment. The meeting then resumed business for a short time, and it was announced that we would adjourn until the following day.

The Astronomical Union was not to hold its first meeting until the following Monday, but with a half day to spend, the word was passed around, and it was agreed that on Friday afternoon the astronomers would hold an informal conference. At this session we were much more at home than in the morning, and with some thirty delegates in a smaller room it was possible to make use of our rapidly increasing knowledge of French. M. B. Baillaud, Director of the Paris Observatory, was chosen temporary chairman of the meeting, while the subsequent sessions of the Union were presided over by M. G. Lecointe, Director of the Royal Observatory of Belgium. Each speaker at the meeting used his own language as a rule, and it was not long before

Mr. Van Biesbroeck was installed as official interpreter. With his facility in both French and English, and his knowledge of astronomy, it was interesting to note how he could summarize a speaker's remarks, and often improve upon the original in the translation. Our English friends were the only delegates who at times spoke in both languages, and their French was of course much more understandable to the Anglo-Saxon ear than the real thing; but on one occasion after one of them had given a splendidly understandable discourse in French, we were surprised to have a Paris friend call out: "Traduction"!

As it turned out that the work of the astronomical conference was to be largely in the discussion and adoption of a constitution or statutes for the Union, there was not much formal work on astronomy proper. During the ten days of the meetings there were formed the permanent organizations of the International Research Council, and the Astronomical, Geophysical, and Chemical Unions, the sessions of the parent body alternating in a general way with those of the individual unions. The drawing up of a constitution is never very exciting work, and it seems that in an international meeting, where there are several languages and many interests, it requires hours or even days to settle points which could be disposed of in a few minutes in a homogeneous national society meeting. Much of the work had been outlined in advance by the Executive Committee of the International Research Council, but even in cases where it was apparently the function of the conference merely to confirm action already taken by the Executive Committee, that could be done only after considerable discussion.

The American delegates were gratified that most of our ideas in regard to the organization of the Astronomical Union were adopted. What seemed to us particularly important was that the work of the Union should be carried on by committees, that these committees should report before the general assembly of the Union, and that there should be no separate sections or divisions of astronomy. This had been the procedure in the highly successful Solar Union, and although the new organization is to cover all branches of the sciences, it was felt that reports on any technical subjects should be discussed before a general meeting where all could attend. Our experiences in the American Section in Washington where most of the committee reports had been circulated in advance , had shown that the plan of a single gathering is quite feasible. Where delegates have to cross the Atlantic and spend a couple of months away from home, the prospect of sessions of the Union extending over a week or more is not alarming.

The following is an unofficial list of the committees of the Union, and their membership, but the Executive Committee was given power to make such changes in the personnel as should be desirable.

COMMITTEES OF THE INTERNATIONAL ASTRONOMICAL UNION.

1. *Committee on Relativity.*
   Eddington, *Chairman;* DeDonder, H. D. Curtis, E. Picard, Brillouin, Jeans, Ishiwara, Ammellini, Levi-Cività.
2. *Committee on Reprinting Old Works.*
   Dreyer, *Chairman;* Crew, Bigourdan, Mascart, Knobel, Terao.
3. *Committee on Notation, Units, and Economy of Publication.*
   Stroobant, *Chairman;* Frost, Boss, Bigourdan, Deslandres, Dyson, Turner.
4. *Committee on Ephemerides.*
   Cowell, *Chairman;* Eichelberger, Dyson, Brown, Andoyer.
5. *Committee on Abstracts and Bibliographies.*
   Baillaud, *Chairman;* Stroobant, Fowle, H. D. Curtis, Bigourdan, Knobel, Millosevich.
6. *Committee on Astronomical Telegrams.*
   Lecointe, *Chairman;* Bailey, Baillaud.
7. *Committee on Dynamical Astronomy and Astronomical Tables.*
   Andoyer, *Chairman;* Brown, Moulton, Leuschner, Hamy, Glaisher, Sampson, Cowell.
8. *Committee on Meridian Astronomy (including the Study of Refraction).*
   Hough, *Chairman;* Philippot, Littell, Boss, Tucker, Porter, Hamy, Bigourdan, de la Baume Pluvinel, Gonnessiat, Dyson, Eddington, ——— (an Australian), Di Legge, Antoniazzi.
9. *Committee on Theoretical and Applied Optical Researches Concerning Astronomy and the Physical Study of Instruments.*
   Hamy, *Chairman;* Delvosal, Sampson, Littell, Conrady, Craty, Lunn, Cotton, Fabry.
10. *Committee on Solar Radiation.*
    Abbot, *Chairman;* Fowle, Deslandres, Callendar, Bemporad.
11. *Committee on "Spectro-Hellio-Enregistreurs des vitesses."*
    Deslandres, *Chairman.*
12. *Committee on the Solar Atmosphere.*
    Hale, *Chairman;* St. John, Lee, Deslandres, Perot, Newall, Fowler, Evershed, Hirayama, Ricco.
13. *Committee on Astronomical Expeditions, Eclipses, etc.*
    De la Baume Pluvinel, *Chairman;* Mitchell, Barnard, Campbell, Angot, Deslandres, Hinks, Fowler, Ricco, Palazzo.
14. *Committee on Standards of Wave-Length and Tables of the Solar Spectrum.*
    St. John, *Chairman;* Meggers, Babcock, Wright, Fabry, Perot, Hamy, Newall, Fowler, Merton, Najaoka.
15. *Committee on Solar Rotation.*
    Newall, *Chairman;* St. John, Adams, Deslandres, Perot, Evershed, Sampson, De Lury.
16. *Committee on Physical Observations of Planets.*
    Cerulli, *Chairman;* Stroobant, Barnard, Lampland, Deslandres, Jarry-Desloges, Mascart, Phillips, Thomson.
17. *Committee on Lunar Nomenclature.*
    Turner, *Chairman;* Puiseux, Bigourdan, Miss Blagg, W. H. Pickering.

18. *Committee on Wireless Determination of Longitudes.*
Ferrié, *Chairman;* Delporte, Hoogewerff, Carty, Dyson, Sampson, Hough, Nakano, Hamy, Bigourdan.

19. *Committee on the Variation of Latitude.*
Kimura, *Chairman;* Schlesinger, Littell, Ross, de la Baume Pluvinel, Bigourdan, Brillouin, Jones, Hills, Larmor, Jeffreys, Celoria, Reina, Bianchi, Volta.

20. *Committee on Minor Planets.*
Brown, *Chairman;* Stroobant, Leuschner, Metcalf, Andoyer, Bigourdan, Gonnessiat, Fayet, Bourget, Crommelin, Cowell, Millosevich, Abetti, Krassowski.

21. *Committee on Comets.*
Leuschner, *Chairman;* Barnard, Andoyer, Fayet, Deslandres, de la Baume Pluvinel, Crommelin, Fowler.

22. *Committee on Meteors.*
Denning, *Chairman;* Mitchell, Olivier, Deslandres, Lebeuf, Mrs. Wilson.

23. *Committee on the "Carte du Ciel."*
Turner, *Chairman;* Lecointe, Delvosal, Baillaud, Cosserat, Gonnessiat, L. Picart, Dyson, Hough, Sampson, Baldwin, Curlewis, Bhaskaran, Ricco, Bemporad, Balbi, Schlesinger, Cook.

24. *Committee on Stellar Parallaxes.*
Schlesinger, *Chairman;* Adams, Mitchell, Fox, Miller, Van Biesbroeck, Bigourdan, Cosserat, Davidson, Dyson, Rambaut, G. Abetti.

25. *Committee on Stellar Photometry.*
Seares, *Chairman;* Miss Leavitt, Parkhurst, Baillaud, Melotte, Eddington, Sampson, Turner, Halm.

26. *Committee on Double Stars.*
Aitken, *Chairman;* Doolittle, Fox, Hussey, Van Biesbroeck, Bigourdan, Jackson, Espin, G. Abetti, Jonckheere.

27. *Committee on Variable Stars.*
Bailey, *Chairman;* Stebbins, Russell, Shapley, Jordan, Mascart, Cosserat, Brook, Turner, Phillips, Plummer, Markwick, Bemporad, Pace.

28. *Committee on Nebulae.*
Bigourdan, *Chairman;* Slipher, Wright, Deslandres, Fabry, Dreyer, Newall, Reynolds, Knox-Shaw.

29. *Committee on Classification of Stellar Spectra.*
Adams, *Chairman;* Miss Cannon, R. H. Curtiss, Russell, Hamy, de Gramont, Fowler, Newall, Plaskett.

30. *Committee on Radial Velocities.*
Campbell, *Chairman;* Adams, Plaskett, Deslandres, Hamy, Newall, Lunt.

31. *Committee on Time.*
Sampson, *Chairman;* Lecointe, Philippot, Hoogewerff, Dyson, Hough, Baillaud, Bigourdan, Ferrié, Celoria.

32. *Committee on the Reform of the Calendar.*
Cardinal Mercier or Bigourdan, *Chairman;* Lecointe, Campbell, Crawford, Deslandres, Dyson, Sampson, Ricco, Millosevich.

As the first steps which led to the holding of the Brussels conference had been taken before the armistice of November 11, 1918, the only nations represented were the allied and associated powers. The International Research Council therefore took the important step of

inviting nations which had been neutral in the war to join the Council on the same basis as the countries already represented. As the conditions for membership in the various Unions are the same as in the Council, there will be uniformity in this regard. A nation desiring to join the International Research Council will do so through its own National Research Council if such exists, or through its National Academy of Sciences or similar body, or through its government, and similarly for membership in the separate Unions. When a country has joined a union it is expected to form a national committee or section in that science, as for instance the American Section of the National Astronomical Union was formed under the auspices of our National Research Council and will continue to serve as a committee of the Division of Physical Sciences of the Research Council. The permanent organization of these national committees will be worked out according to the conditions in each country.

At the close of the astronomical meeting in Brussels, officers were chosen who will act as an executive committee, and in particular direct the affairs of the Union between meetings.

President	B. Baillaud, Director of the National Observatory, Paris
Vice-Presidents	W. W. Campbell, Director Lick Observatory, Mt. Hamilton Sir F. W. Dyson, Astronomer Royal, Greenwich G. Lecointe, Director Royal Observatory, Brussels A. Ricco, Director of the Royal Observatory, Catania
Secretary	A. Fowler, Professor of Astrophysics in the Imperial College of Science, South Kensington

The meetings of the Union will be held ordinarily every three years, and it was voted that the next conference be held in Rome in 1922.

During the ten days in Brussels we had opportunity to see a good deal of the city and its life, and in particular there was the Belgian peace celebration beginning July 21, when President Poincaré and Marshall Foch came for the occasion. There were also special events in honor of the visiting men of science, beginning with a soirée given on the first evening at the Hotel de Ville by the "College des Bourgmestre et Echevins et le Conseil Communal de la Ville de Bruxelles". After a special concert organized by the "Société des Concerts Historiques", the visitors had the privilege of inspecting the art treasures of the building and to meet the foremost citizens of Brussels with the famous Bourgmestre Max as our chief host. Later during the conference there was also a reception for the delegates by the Minister of Sciences and Arts, and Madame Harmignie; and one by the Minister of Foreign Affairs, and Madame Hymans; while many of the visitors were also privileged to gain further insight into Belgian life at private entertainments. The astronomers were glad of the opportunity to inspect the Royal Observatory at Uccle, a suburb of Brussels.

There were very few physical ravages of war in the neighborhood

of Brussels, but most of us made visits to Louvain and Dinant. After the meeting all who could do so made up a party and had a day's motor tour of the battlefields in Belgium under the guidance of Mr. Stratton of the Cambridge Observatory, who had served in the British army during the entire war, entering as captain and coming out a lieutenant-colonel. Although most of the party were then returning to England, a few of us persuaded Mr. Stratton to continue his visits to his former homes, varying from chateaus to dugouts, and we had a never to be forgotten day on the Somme east of Amiens. Certainly after seeing the devastation in Belgium and France there were none of us who felt that any peace terms could be too severe upon the originators of the war.

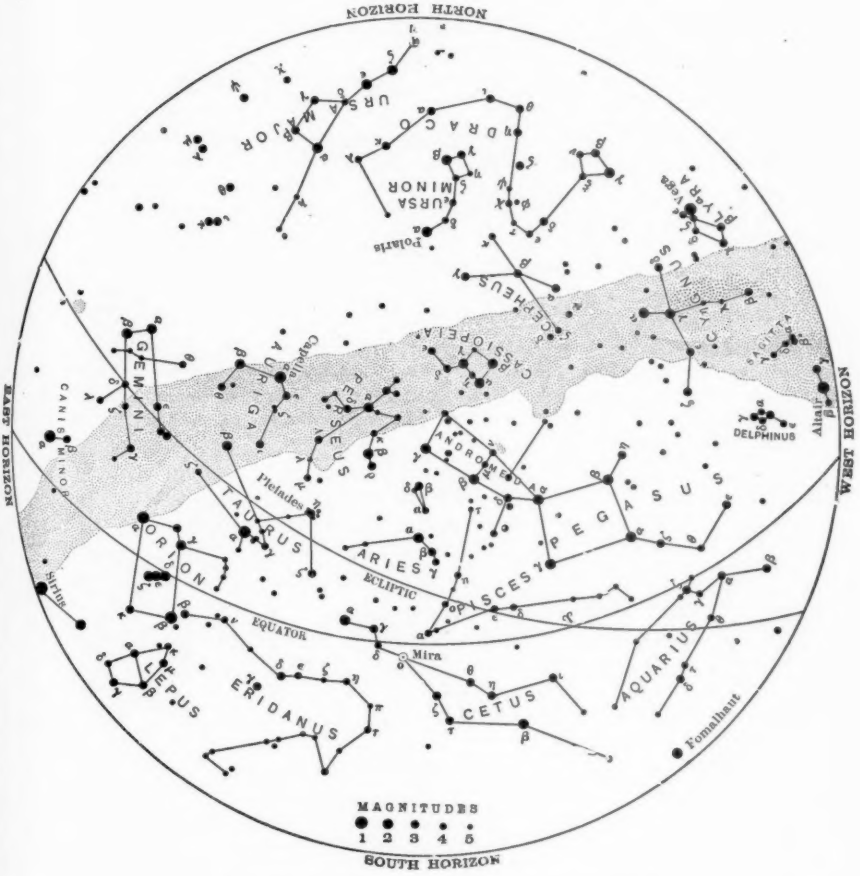
The Americans were well scattered within a few days after the conference. Several went to Paris, others to Holland, and still others direct back to England. They all report further hospitality and profitable visits with scientific friends.

No account of the American delegation would be complete without mention of what was our most frequent topic of conversation while abroad. The one question which was constantly being asked was: "What have you heard about steamers?" The United States government had given us recognition in the form of special passports, but as the return movement of troops was at its height, we found that civilians were left to shift for themselves in the matter of getting home. With a dozen applicants for every berth, there seemed small chance of getting passage in any time short of several months, but in one way or another all of our members got back without having to patronize the steerage, and by the middle of September we were home at our respective institutions.

Viewed in retrospect the Brussels conference will no doubt be seen as an epoch making step in the history of science. While at this meeting there was very little but organization accomplished, the International Research Council will serve as a means of international coöperation much more efficient than any previous agency. The different Unions were started on a sound basis, and in particular we feel that the Astronomical Union will flourish. Although the various scientific reports of the American committees were not discussed much at the Conference, these preparations will be of great value to the various international committees which were appointed, and which will make reports three years hence in Rome. To the American astronomers the hospitality which we received in each country was particularly pleasant, and not the least item of profit was the opportunity to talk over matters of mutual scientific interest and to get better acquainted with the members of our own party.

University of Illinois Observatory, October, 1919.

PLANET NOTES FOR DECEMBER, 1919.



THE CONSTELLATIONS AT 9:00 P. M. DECEMBER 1.

The *sun* will be 21° 41′ south of the equator on the first of the month. On December 22 it will reach its greatest southern declination, — 23° 26′ 51″. By the end of the month it will have again started north and will have reached a position of — 23° 9′ 27″. It will move eastward from Scorpio into Sagittarius.

The phases of the *moon* for the month are as follows:

Full Moon	Dec.	7	at 4	A.M.	C.S.T.
Last Quarter		13	" 12	P.M.	"
New Moon		21	" 5	A.M.	"
First Quarter		29	" 11	P.M.	"

Mercury will begin in the month with retrograde motion which will bring it to a point of greatest elongation west on December 21. After this date it will move eastward more rapidly than the sun. At the time of elongation it will rise an hour and a half before the sun.

Venus will keep almost an exact pace with the sun in its motion eastward during the month. It will remain throughout the month about three hours west of the sun. Being farther north than the sun it will rise more than three hours before the sun in the northern hemisphere, and will be a brilliant morning star.

Mars will be moving eastward more slowly than the sun, and will therefore rise earlier from day to day. It will be near the meridian at sunrise. This planet will be in the constellation Virgo and at the end of the month will be about six degrees north of the bright star Spica.

Jupiter will rise before midnight and therefore will again be coming into position for observation. From December 5 until the end of the month it will have retrograde motion, which will cause it to rise nearly six minutes earlier each night at the end of the month. It will be found in the constellation Leo, a short distance west of Regulus.

Saturn will move slowly eastward in the constellation Leo until December 24, and will then move westward for the rest of the month. On December 4 it will be in quadrature, 90 degrees west of the sun. Near this date it will rise at midnight.

Uranus will be in the western sky in the evening during this month. It will be found in the constellation Aquarius.

Neptune will be a short distance northwest in the sky from Jupiter. It will be well up in the sky at midnight. It will be in the constellation Cancer.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1919	Star's Name	Magnitude	IMMERSION Washington M.T.		Angle from N.	EMERSION Washington M.T.		Angle from N.	Duration	
			h	m	°	h	m	°	h	m
Dec. 2	51 Piscium	5.6	7	18	89	8	29	213	1	10
7	χ^1 Orionis	4.5	13	52	86	15	4	292	1	12
7	64 Orionis	5.1	18	11	122	19	0	259	0	50
9	1 Cancri	6.0	12	5	77	13	13	313	1	8
10	A^2 Cancri	5.7	8	47	139	9	30	244	0	43
10	60 Cancri	5.7	13	4	116	14	22	287	1	18
13	388 B Leonis	6.3	12	50	55	13	24	353	0	34
18	11 H Libræ	5.4	16	29	106	17	35	289	1	6
28	9 Piscium	6.4	9	15	64	10	18	250	1	3
28	κ Piscium	4.9	9	20	27	10	9	287	0	49

Occultations Visible in the United States, December, 1919.

(NOTE:—Geographical positions are indicated by giving for each point, first the latitude, then the longitude, the two being separated by a hyphen. A line drawn on a map through the two or three points thus indicated will mark the limit of the region of visibility.)

Dec. 1. 16 Piscium, Mag. 5.7. Southeast of 25° - 100°, 39° - 75°. (West of about 90° long. the whole occultation occurs before sunset.)

Dec. 1. 19 Piscium, Mag. 5.4. South of 29° - 105°, 31° - 90°, 32° - 80°.

Dec. 2. 51 Piscium, Mag. 5.6. Visible throughout the U. S. except the southern extremity of Florida.

Dec. 3. π Piscium, Mag. 5.6. North of 37° - 122°, 43° - 96°, 43° - 70°.

Dec. 5. 175 B Arietis, Mag. 6.4. Visible in Florida south of 30° latitude.

Dec. 5. 14 Tauri, Mag. 6.2. South of 30° - 105°, 26° - 80°.

Dec. 6. 282 B. Tauri, Mag. 6.4. Northwest of 30° - 110°, 40° - 86°, 47° - 67°.

Dec. 6. 129 H^1. Tauri, Mag. 5.8. South of 25° - 100°, 35° - 76°.

Dec. 7. B.D. + 19°1110, Mag. 6.0. North of 43° - 124°, 48° - 90°, 45° - 68°.

Dec. 7. χ^1 Orionis, Mag. 4.5. Visible throughout the U. S.

Dec. 7. 57 Orionis, Mag. 5.8. Visible in northern Maine.

Dec. 7. 64 Orionis, Mag. 5.1. North of 43° - 125°, 35° - 102°, 25° - 80°.

Dec. 7. χ^2 Orionis, Mag. 4.7. South of 50° - 124°, 40° - 96°, 32° - 77°.

Dec. 8. 68 Orionis, Mag. 5.7. South of 48° - 123°, 43° - 112°, and west of longitude 112°.

Dec. 9. 1 Cancri, Mag. 6.0. South of 43° - 123°, 48° - 90°, 45° - 61°.

Dec. 10. 30 B. Cancri, Mag. 6.1. Southwest of 50° - 96°, 39° - 74°. (East of about 87° longitude the whole occultation occurs after sunrise.)

Dec. 10. A^2 Cancri, Mag. 5.7. East of 49° - 96°, 40° - 89°, 32° - 78°.

Dec. 10. 60 Cancri, Mag. 5.7. Visible throughout the U. S.

Dec. 10. α Cancri, Mag. 4.3. South of 33° - 120°, 33° - 100°, 29° - 80°.

Dec. 11. κ Cancri, Mag. 5.1. Southwest of 49° - 115°, 40° - 99°, 31° - 80°. (East of about 95° longitude the whole occultation occurs after sunrise.)

Dec. 13. 237 B. Leonis, Mag. 6.3. Throughout the U. S., but east of 30° - 113°, 49° - 94°, the whole occultation occurs after sunrise.

Dec. 13. 388 B. Leonis, Mag. 6.3. South of 42° - 94°, 41° - 73°, and east of 42° - 94°, 28° - 100°.

Dec. 15. 49 Virginis, Mag. 5.2. South of 45° - 112°, 40° - 94°, 34° - 78°, and east of 45° - 112°, 40° - 118°, 34° - 121°.

Dec. 18. 11 H. Libræ, Mag. 5.4. East of 45° - 86°, 38° - 89°, 30° - 89°, (Emersion only).

Dec. 27. κ Aquarii, Mag. 5.2. Northwest of 45° - 126°, 50° - 117°.

Dec. 27. 207 B. Aquarii, Mag. 6.3. North of 32° - 119°, 35° - 108°, 37° - 88°, and west of 37° - 88°, 49° - 82°.

Dec. 28. 22 B. Piscium, Mag. 6.4. Northwest of 29° - 104°, 40° - 85°, 48° - 64°. (Southwest of 49° - 118°, 33° - 97°, the whole occultation occurs before sunset.)

Dec. 28. κ Piscium, Mag. 4.9. South of 33° - 119°, 42° - 94°, 45° - 64°.

Dec. 28. 9 Piscium, Mag. 6.4. Throughout the U. S. except northwest of 43° - 124°, 49° - 110°.

Dec. 28. 16 Piscium, Mag. 5.7. West of 49° - 120°, 40° - 118°, 30° - 119°, (Emersion only).

Dec. 31. 19 Arietis, Mag. 5.8. South of 30° - 105°, 28° - 90°, 25° - 80°.

ARTHUR SNOW.

Assistant, Nautical Almanac Office, U. S. Naval Observatory.

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by D. C. Kazarinoff at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1919 December							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	6 15							
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	7 3;	14 19;	22 11;	30 3				
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	1 19;	9 5;	16 16;	24 2				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	6 4;	13 16;	21 3;	28 15				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 21;	13 0;	19 3;	25 6				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	4 10;	11 14;	18 17;	25 20				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	7 13;	14 10;	21 7;	28 4				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	6 0;	13 4;	20 8;	27 12				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	8 2;	16 21;	25 15;	28 13				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	8 6;	16 5;	24 4;	29 11				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6								
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	5 17;	17 4;	22 22;	28 15				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	6 22;	13 17;	20 12;	27 7				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	4 10;	12 8;	20 5;	28 3				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	8 12;	16 19;	20 23;	25 3				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	7 6;	15 4;	23 1;	30 23				
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	8 12;	21 17						
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	4 13;	14 0;	23 11;	29 18				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	1 19;	14 5;	26 15					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	5 19;	11 10;	18 2;	24 18				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	3 17;	10 21;	19 1;	27 6				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	4 10;	10 10;	16 11;	22 11				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	4 17;	13 9;	22 1;	30 17				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	10 0;	20 9;	25 14;	30 19				
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	7 20;	15 20;	23 20;	31 21				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	7 1;	12 19;	24 6;	29 23				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	5 5;	10 19;	22 0;	27 15				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	7 23;	12 1;	16 3;	24 8				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	7 23;	15 14;	23 5;	30 20				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0		10 23;	23 4					
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	3 23;	11 3;	18 7;	25 11				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	8 0;	14 19;	21 15;	28 11				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	9 21;	19 4;	28 11					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	9 15;	16 6;	22 20;	29 11				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	8 5;	16 15;	25 0;	30 14				
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	7 19;	14 5;	20 15;	27 2				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	7 21;	15 3;	22 10;	29 16				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	3 10;	11 13;	19 16;	27 19				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6		10 0;	19 12;	28 23				
RX Hydrae	9 00.8	− 7 52	9.1—10.5	2 6.8	4 10;	11 6;	18 3;	24 23				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	8 16;	14 14;	20 13;	26 11				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	3 15;	10 9;	17 3;	23 21				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	8 15;	16 1;	23 11;	30 21				
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	7 4;	13 19;	20 9;	27 0				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	1 14;	10 10;	19 4;	28 0				
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	6 18;	14 2;	21 10;	28 18				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	5 0;	11 19;	18 14;	25 9				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	1 22;	9 11;	16 23;	24 11				
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	9 17;	19 7;	24 2;	28 21				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	4 7;	11 16;	19 2;	26 13				
133926 Hydrae	13 39.0	−26 23	8.6—12.7	2 21.5	3 9;	9 4;	20 19;	26 13				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	7 18;	14 17;	21 17;	28 17				

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1919 December
	h m	° ′		d h	d h d h d h d h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	6 3; 13 1; 19 23; 26 20
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.3	6 14; 15 0; 23 10; 31 21
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	1 18; 9 10; 17 2; 24 18
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	1 19; 9 4; 16 12; 23 20
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	5 23; 14 5; 22 11; 30 18
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	7 4; 11 14; 16 0; 24 21
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	1 11; 11 3; 22 5; 31 22
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	4 21; 11 16; 18 11; 25 7
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	4 6; 12 15; 21 0; 29 9
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	6 19; 12 22; 19 2; 25 6
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	5 2; 12 7; 19 13; 26 18
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	8 7; 15 16; 23 1; 30 10
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	6 8; 14 13; 22 17; 30 21
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	1 5; 8 18; 23 20; 31 9
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	1 4; 8 22; 16 16; 24 10
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	4 15; 12 15; 20 15; 28 14
WX Sagittae	53.6	—17 24	9.2—10.8	2 03.1	5 15; 14 4; 22 16; 31 4
WY Sagittae	17 54.9	—23 1	9.5—10.6	4 16.0	8 3; 12 19; 17 11; 26 19
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	8 19; 19 13; 24 7; 29 12
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	3 19; 11 0; 18 6; 25 12
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	4 2; 10 23; 24 19; 31 17
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	9 15; 24 18
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	2 16; 9 20; 17 0; 24 4
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	3 5; 10 8; 17 11; 24 14
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	8 15; 12 18; 16 22; 25 6
RR Draconis	40.8	+62 34	9.3—13	2 19.9	7 23; 16 11; 24 23; 30 15
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	7 9; 14 0; 20 16; 27 7
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	9 15; 16 2; 22 13; 29 0
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	1 11; 9 2; 16 17; 24 9
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	6 17; 14 7; 21 21; 29 10
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	1 19; 8 23; 23 9; 30 14
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	5 16; 14 15; 23 14; 28 1
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	2 23; 9 18; 16 12; 23 6
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	1 6; 8 15; 16 0; 23 9
TT Lyrae	24.3	+41 30	9.4—11.6	5 05.8	4 6; 9 12; 14 18; 25 6
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 21; 9 10; 15 22; 28 23
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	3 21; 9 22; 21 22; 27 22
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	6 14; 13 6; 19 21; 26 12
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	7 9; 16 12; 25 16; 30 6
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	7 10; 15 21; 24 7
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	3 6; 10 1; 16 19; 23 14
UW Cygni	19.6	+42 55	10.5—13	3 10.8	5 23; 12 21; 19 18; 26 16
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0	13 15
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	9 14; 19 5; 24 0; 28 19
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	6 19; 15 23; 20 13; 25 4
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	1 21; 9 9; 16 21; 24 9
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	1 23; 9 13; 17 3; 24 18
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	4 9; 14 12; 24 14; 29 15
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	6 22; 14 8; 21 17; 29 2
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	1 22; 11 15; 21 7; 31 0
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	4 15; 12 12; 20 9; 28 6
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	2 14; 12 17; 22 21; 27 23
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	24 14
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	4 4; 9 9; 19 18; 30 2
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.4	7 8; 15 20; 24 3; 26 21
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.3	5 6; 12 19; 20 7; 27 20
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	4 20; 13 2; 21 8; 29 14

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5h; Central standard time 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1919. December							
	h m	° ′		d h	d	h	d	h	d	h	d	h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	7	6						
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	5	22;	14	1;	22	4;	30	8
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	7	14;	15	8;	23	2;	27	23
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	8	17;	23	12;				
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	5	14;	13	12;	21	11;	29	9
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	3	6;	11	2;	18	20;	26	15
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	7	23;	15	6;	22	13;	29	19
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0			12	0;	28	0		
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	5	14;	14	4;	22	18;	31	8
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1			11	16;	22	19		
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0			10	9;	21	0		
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	2	3;	9	18;	17	10;	25	2
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3			10	20;	20	23;	31	2
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	4	9;	12	2;	19	20;	27	13
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	7	1;	12	13;	18	2;	23	15
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	7	1;	14	14;	22	4;	29	17
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	9	8						
RT Aurigae	23.0	+30 33	5.1— 6.0	3 17.5	2	20;	10	6;	17	17;	25	4
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	6	14;	13	19;	21	0;	28	5
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	5	12;	13	10;	21	8;	29	6
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	4	4;	14	8;	24	12		
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	3	17;	26	0				
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	4	22;	12	20;	20	19;	28	18
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	4	16;	11	8;	18	1;	24	18
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	4	1;	13	8;	22	14;	31	21
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	1	20;	10	13;	19	7;	28	1
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0			16	0				
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	2	17;	9	12;	16	7;	23	2
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	6	4;	12	19;	19	9;	26	0
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	7	22;	17	13;	27	5		
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	4	13;	12	12;	20	12;	28	11
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	6	2;	12	20;	19	13;	26	7
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	3	19;	9	15;	15	11;	22	7
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	3	6;	12	15;	22	0;	31	9
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5			17	23				
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	5	20;	14	0;	22	5;	30	10
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	5	15;	12	15;	19	16;	26	16
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	5	3;	13	8;	21	13;	29	18
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	6	12;	12	0;	17	12;	23	0
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	2	5;	9	18;	17	7;	24	21
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	5	21;	13	7;	20	17;	28	3
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	2	2;	8	21;	15	16;	22	10
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	1	23;	8	7;	14	15;	20	23
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	2	2;	11	20;	21	14;	31	8
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	4	8;	13	4;	22	1;	30	21
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	1	15;	7	16;	19	19;	31	22
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	5	5;	12	5;	19	6;	26	6
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9			12	5;	29	8		
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	6	5;	13	20;	21	10;	29	0
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	6	6;	12	0;	17	19;	23	13
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	7	7;	14	1;	20	19;	27	13
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	4	20;	15	4;	25	13		
Y Lyrae	34 2	+43 52	11.3—12.3	0 12.1	6	7;	12	7;	18	8;	24	9
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	4	2;	10	5;	22	11;	28	15

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1919. December
	h m	° ′		d h	d h d h d h d h
RT Scuti	18 44.1	−10 30	9.1— 9.7	0 11.9	3 22; 9 20; 15 19; 27 17
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	9 15; 18 17; 27 19
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	7 14; 14 15; 21 16; 28 16
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	2 21; 9 21; 16 21; 23 21
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	7 0; 14 23; 22 23; 30 22
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	8 16; 16 11; 24 2; 31 18
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	5 20; 12 0; 19 4; 26 9
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	8 15; 17 0; 25 10
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	5 3; 11 10; 17 18; 24 2
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	6 12; 22 21
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	6 14; 15 11; 19 21; 28 18
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	6 5; 12 22; 19 16; 26 9
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	2 14; 15 0; 22 17; 29 10
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	7 3; 21 20
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	3 20; 11 16; 19 13; 27 10
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	4 14; 11 11; 18 8; 25 6
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	6 21; 11 18; 21 11; 31 4
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	2 20; 11 12; 20 3; 28 19
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	2 3; 7 12; 18 5; 28 23
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	1 8; 12 5; 23 2
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	5 7; 11 17; 18 3; 24 13
V Lacertae	44.5	+55 48	8.5— 9.5	4 23.6	4 23; 14 22; 24 21; 29 21
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.7	5 13; 11 0; 16 11; 21 21
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	4 5; 9 15; 20 12; 31 10
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	1 12; 7 19; 20 9; 26 17
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	3 19; 15 23; 28 2
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.9	6 4; 13 4; 20 3; 29 3

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, September-October, 1919.

With the return of better observing conditions and vacations over, a marked increase is to be noted in the number of lists submitted and in their length. It is a pleasure to welcome Messrs. Lacchini and Spinney back to the ranks of active observers, and the splendid contributions of Messrs. McAteer, Pickering, and Bancroft deserve special commendation. Four new observers have contributed to this report under the following abreviations:—

Sterling Bunch, Bh, Springtown, Texas; C. C. Godfrey, Gd, Bridgeport, Conn.; J. W. L. Henckel, Hn, Yonkers, N. Y.; William Hodgkinson, Jr., Hk, Framingham, Mass.

The well marked minimum of R Coronae Borealis, 154428, was observed by nearly all our members, and indicates the necessity of carefully watching this star. SS Aurigae, 060547, was caught at its first maximum since it passed the sun by Professor Mitchell, Miss Young, and Messrs. McAteer and Pickering.

Variable Star Observations, September, 1919.

Aug. 0 = 2422171 Sept. 0 = 2422202 Oct. 0 = 2422232

001046 X Androm.

J.D. 242	Est.	Obs.
2196.6	<13.3	Ba
2229.6	14.0	E

001755 T Cassiop.

J.D. 242	Est.	Obs.
2180.7	8.5	Ba
91.6	8.0	
92.3	9.5	L
97.3	9.7	Pe_3
2200.4	8.8	L
09.7	8.9	M
22.6	8.0	Cl
22.6	8.1	B
22.6	8.0	K
27.8	8.7	M
29.7	8.5	Pi

001726 T Androm.

J.D. 242	Est.	Obs.
2173.5	8.4	Ja
76.3	8.5	Pe_2
80.7	8.3	Ba
91.0	8.4	Pe_3
94.4	8.7	Ja
98.4	9.0	Pe_2
2203.5	9.0	Ja
08.7	9.4	M
28.6	9.9	Cl
28.6	9.9	B
29.7	10.2	Pi

001838 R Androm.

J.D. 242	Est.	Obs.
2190.8	12.1	Pe_2
2201.3	10.5	Pe
09.7	9.6	M
17.7	8.9	Pt
25.6	7.9	V
29.5	7.6	Cl
29.7	7.5	Pi
31.5	7.6	B
31.5	7.4	Sp
31.7	7.9	Me

003179 Y Cephei

J.D. 242	Est.	Obs.
2191.6	10.5	Ba
2227.8	12.1	M

004047 U Cassiop.

J.D. 242	Est.	Obs.
2172.3	9.3	Pe
90.8	9.5	Pe_2
91.6	9.7	Ba
98.4	9.7	Pe_2
2222.6	10.0	Cl
22.6	10.2	B
22.6	10.0	K

U Cassiop.

J.D. 242	Est.	Obs.
2227.8	11.3	M
28.6	11.0	Y
29.6	10.7	E
30.5	11.4	Pi

004132 RW Androm.

2229.6<13.7 E

004435 V Androm.

2229.6<13.1 E

004533 RR Androm.

2229.6<12.6 E

004746a RV Cassiop.

2191.6 12.9 Ba

004958 W Cassiop.

J.D. 242	Est.	Obs.
2180.7	9.0	Ba
91.6	9.0	
2208.7	9.7	M
22.6	9.0	Cl
22.6	8.8	B
22.6	9.0	K
30.5	9.1	Pi

010940 U Androm.

J.D. 242	Est.	Obs.
2196.6	9.6	Ba
2208.7	10.2	M
28.6	10.5	Cl
28.6	10.7	B
29.6	10.8	E

011041 UZ Androm.

J.D. 242	Est.	Obs.
2196.6	11.4	Ba
2208.7	10.3	M
28.5	10.0	Cl
28.5	9.9	B
28.5	10.1	Sp
29.6	9.2	E

011272 S Cassiop.

2191.6<13.0 Ba
2226.5<12.3 Pi

011208 S Piscium.

2195.5 13.3 Ja
2228.6<13.6 Y

011712 U Piscium

J.D. 242	Est.	Obs.
2229.6	12.2	E
29.8	<12.4	M

012350 RZ Persei

J.D. 242	Est.	Obs.
2191.6	11.8	Ba
2228.6	12.3	Y
29.6	12.5	E

012502 R Piscium

J.D. 242	Est.	Obs.
2180.7	8.5	Ba
95.5	9.0	Ja
2201.4	9.1	Pe
25.7	9.7	Pt
27.8	10.4	M
28.6	10.7	Y

013238 RU Androm.

J.D. 242	Est.	Obs.
2227.6	10.5	E
28.6	10.5	B
31.6	10.5	Pi

013338 Y Androm.

J.D. 242	Est.	Obs.
2227.6	13.4	E
28.5	13.4	Cl
28.5	13.8	B
28.5	13.4	Sp

014958 X Cassiop.

J.D. 242	Est.	Obs.
2219.5	10.8	B
19.5	10.9	K
28.6	11.0	Y
30.5	10.9	Pi
30.8	11.3	M

015354 U Persei.

J.D. 242	Est.	Obs.
2180.7	8.2	Ba
91.7	8.9	
2207.6	9.1	B
29.8	9.3	M
30.5	9.5	Pi

021024 R Arietis

J.D. 242	Est.	Obs.
2180.7	11.0	Ba
93.4	10.4	Pe
2201.4	10.4	
25.7	8.7	Pt
27.8	8.9	M
31.6	8.5	Pi

021143a W Androm.

J.D. 242	Est.	Obs.
2231.5	10.2	B
31.5	9.9	Sp
31.6	10.0	Pi

021281 Z Cephei

2214.8<11.4 M

021403 o Ceti.

J.D. 242	Est.	Obs.
2155.6	3.6	Lt
72.5	3.3	Lt_2
73.5	3.3	Ja
74.0	3.2	Pe_2
79.4	3.3	Pe_6
80.6	3.3	Lt_5
89.0	3.3	Lt_2
91.1	3.3	Pe_7
94.5	3.2	L
94.5	3.7	Ja
97.6	3.5	Pe_2
98.5	3.3	Lt
99.5	3.8	Ja
2201.6	3.2	L
03.8	3.5	M
05.0	3.8	Ja_2
09.9	3.6	Pt
18.7	4.1	
21.8	3.8	Mu
27.8	4.0	M

021558 S Persei

J.D. 242	Est.	Obs.
2180.7	8.8	Ba
91.7	8.6	
2206.6	8.9	B
06.6	9.3	Cl
06.6	9.0	K
29.8	9.0	M
31.6	9.5	Pi

022000 R Ceti.

J.D. 242	Est.	Obs.
2194.5	8.0	Ja
2228.8	8.6	M

022150 RR Persei

J.D. 242	Est.	Obs.
2228.6	13.0	Y
29.8	12.4	M

022813 U Ceti

J.D. 242	Est.	Obs.
2219.8	8.6	E
28.8	8.5	M

023080 RR Cephei

2214.8<11.4 M

023133 R Trianguli

J.D. 242	Est.	Obs.
2180.7	11.0	Ba
2203.8	9.9	M
22.6	8.9	B

024356 W Persei

J.D. 242	Est.	Obs.
2178.7	9.3	Pe_3
80.7	8.6	Ba
97.4	9.2	Pe_2
2203.8	9.0	M
07.6	9.1	B
16.6	9.3	Pt
28.8	9.4	M

030514 U Arietis

2219.8 13.0 E

031401 X Ceti

2226.8 9.1 M

032043 Y Persei

J.D. 242	Est.	Obs.
2180.7	8.3	Ba
93.4	9.8	Pe
97.1	9.5	Pe_3
2207.6	8.5	B
17.7	9.4	Pt
28.8	9.3	M

032335 R Persei

J.D. 242	Est.	Obs.
2219.8	9.6	E
28.8	9.8	M

033362 U Camelop.

J.D. 242	Est.	Obs.
2180.7	7.0	Ba
2228.8	7.2	M

035915 V Eridani

2219.8 8.5 E

041619 T Tauri

J.D. 242	Est.	Obs.
2206.8	9.9	M
26.8	9.6	

042215 W Tauri

J.D. 242	Est.	Obs.
2203.8	9.9	M
08.8	9.8	
19.8	9.9	E
26.8	9.6	M

042209 R Tauri

2226.8<12.4 M

VARIABLE STAR OBSERVATIONS, September, 1919—Continued.

042309
S Tauri
J.D. Est. Obs.
242
2226.8 11.8 M

043065
T Camelop.
2191.6 9.4 Ba
97.8 9.8 L_2
2226.8 10.8 M

043274
X Camelop.
2191.6 9.8 Ba
2226.8 8.4 M
28.6 8.0 Y

043208
RX Tauri
2206.8 9.5 M
19.7 9.4 E
26.8 10.1 M

044617
V Tauri
2228.8 10.4 M

045514
R Leporis
2198.6 9.1 L
2225.9 8.6 M
28.9 9.1 Pt

050003
V Orionis
2228.8 9.1 M

050022
T Leporis
2225.9<11.3 M

050953
R Aurigae
2228.7<12.3 Pi

052036
W Aurigae
2219.8<11.3 M

052034
S Aurigae
2194.6 9.7 L
2201.6 10.1
19.8 9.7 M
28.7 9.2 Pi

052404
S Orionis
2230.8 12.6 M

053068
S Camelop.
2229.8 10.5 M

053005a
T Orionis
2194.6 10.0 L
2229.8 10.2 M

053326
RR Tauri
J.D. Est. Obs.
242
2227.8 11.0 M

053531
U Aurigae
2229.8 11.1 M

054319
SU Tauri
2194.6 9.7 L
2201.6 9.6
04.5 9.6 Ja
06.8 9.6 M
19.8 9.4 E
28.7 9.4 Pi
29.7 9.4 E

054974
V Camel.
2228.6<13.0 Y

054920
U Orionis
2206.8 8.0 M
28.7 8.7 Pi
28.9 8.9 Pt

055353
Z Aurigae
2226.8 10.6 M
28.7 10.8 Pi

060450
X Aurigae
2228.7 11.8 Pi

060547
SS Aurigae
2194.6<12.4 L
98.6<13.3
2201.6<12.4
19.7<11.4 E
28.6 11.0 Y
28.7 11.0 Pi
28.8 11.2 M
29.6 11.0 Y
29.7 11.0 Pi
29.8 11.2 M
29.8 11.1 E
30.8 11.4 M
33.7<11.4 E

061647
V Aurigae
2226.8 9.8 M

061702
V Monoc.
2228.8 9.2 M

063159
U Lyncis
2229.8<12.6 M

063308
R Monoc.
J.D. Est. Obs.
242
2229.8 9.9 M

063558
S Lyncis
2229.8<12.6 M

064030
X Gemin
2229.8 12.1 M

064707
W Monoc.
2229.8 10.4 M

065111
Y Monoc.
2229.8 10.2 M

065208
X Monoc.
2229.8 7.3 M

065355
R Lyncis
2229.8 12.3 M

070122a
R Gemin.
2225.9 7.4 M
28.9 7.0 Pt

070122b
Z Gemin.
2225.9<11.8 M

071713
V Gemin.
2230.8 11.4 M

072708
S Can. Min.
2225.9 7.6 M
28.9 7.6 Pt

073508
U Can. Min.
2225.9 9.7 M

073723
S Gemin.
2225.9 10.0 M

074323
T Gemin.
2229.8 8.9 M

074922
U Gemin.
2198.6<10.9 L
2225.9<12.4 M
28.7<11.4 Pi
30.8<12.4 M

081617
Y Cancri
2228.9 8.8 Pt

085120
T Cancri
J.D. Est. Obs.
242
2110.4 9.4 L

094211
R Leonis
2110.4 8.2 L

103769
R Urs. Maj.
2196.6 12.1 Ba
2225.9<12.0 M

123160
T Urs. Maj.
2190.3 12.2 Pe
96.6 13.0 Ba
2201.3 12.2 Pe
15.5<12.4 Pi
20.5 12.4 B

123459
RS Urs. Maj.
2176.3 9.4 Pe_2
80.6 9.3 Ba
88.3 10.1 Pe_3
95.5 10.0 Ba
98.3 10.6 Pe_2
2220.5 11.5 B

123961
S Urs. Maj.
2172.4 8.6 L
78.3 8.3 Pe_3
80.6 8.3 Ba
86.3 8.2 L
88.3 8.6 Pe_3
95.5 8.0 Ba
98.3 8.4 L
2201.3 8.3 Pe
14.6 8.5 Pt
15.5 8.3 Pi
20.5 8.2 B
27.5 7.7 Cl
27.5 7.8 K

132422
R Hydrae
2110.4 7.7 L

134440
R Can. Ven.
2174.3 7.7 Pe
79.8 7.6 Pe_2
86.8 7.9
2217.6 8.4 Pt
22.6 8.5 M

140113
Z Bootis
2229.6<12.6 Y

141567
U Urs. Min.
J.D. Est. Obs.
242
2180.7 7.7 Ba
95.5 8.0
2215.6 8.8 Pi

141954
S Bootis
2180.6 9.0 Ba
86.3 8.8 L
88.0 9.0 Pe_3
95.5 9.4 Ba
98.3 9.5 L
98.4 9.4 Pe_2
2222.5 9.9 B
27.5 10.2 Pi

142584
R Camelop.
2180.6 10.4 Ba
95.5 11.0
2207.6 11.6 B
15.6 12.0 Pi

142539
V Bootis
2180.6 8.8 Ba
83.3 9.2 Pe_2
87.8 9.3
88.4 9.3 L
98.3 9.5
2215.5 10.0 Pi
22.6 9.6 M
28.6 10.0 Wg
29.5 10.2 Pi_2

143227
R Bootis
2173.3 7.0 Pe
78.3 7.5 Pe_3
87.8 8.5 Pe_2
95.4 8.8 Pe
96.6 9.0 Ba
2215.5 10.5 Pi
22.6 10.0 M
27.5 11.1 Pi
29.6 11.2 B

144918
U Bootis
2196.6 10.8 Ba
2227.5 11.4 Pi

151731
S Cor. Bor.
2195.5 12.6 Ba
2220.6 12.7 B
20.6 13.0 Y
28.5 13.2 E

151714
S Serpentis
2189.4 8.1 L
2200.3 8.6

VARIABLE STAR OBSERVATIONS, September, 1919—Continued.

153378
S Urs. Min.

J.D. 242	Est.	Obs.
2180.6	9.3	Ba
2206.5	8.8	B
06.5	8.8	K
21.6	9.2	V
26.5	9.2	Pi
27.6	9.2	Gd

154428
R Cor. Bor.

2112.4	5.9	L
21.4	6.1	
26.4	5.9	
75.4	5.9	Pe
80.6	6.0	Ba
90.4	6.0	L_2
90.4	6.1	Pe
91.5	6.0	Ba
95.5	6.0	
96.5	6.0	
97.5	6.1	
98.3	6.0	L
2206.7	6.3	Mu
14.7	6.4	
15.5	6.5	Pi
15.6	6.6	Bn
16.7	6.7	Mu
17.6	6.5	Pt
19.7	6.9	Mu
20.6	7.0	Hn
21.6	7.0	V
22.6	6.9	Ya
22.6	6.9	Su
22.6	6.2	M
22.7	6.8	Mu
24.7	6.9	
25.6	6.4	Pt
25.6	6.6	Su
25.6	7.0	Hn
26.6	6.5	Pt
27.5	6.8	Pi
27.7	6.8	Mu
28.5	6.8	Pi
28.6	6.6	Bn
28.6	6.6	Wg
28.7	6.5	Pt
29.6	6.6	Su
29.6	7.0	Hn
29.7	6.7	Me
30.5	6.6	Pi
31.5	6.5	

154536
X Cor. Bor.

2196.6	9.9	Ba
2219.6	9.5	B
21.6	9.2	V
22.6	9.1	M

154639
V Cor. Bor.

J.D. 242	Est.	Obs
2169.6	8.4	Ba
2222.6	9.3	M
28.5	8.9	Pi

154615
R Serpentis

2194.4	12.6	Ja
2219.5	12.8	B
19.5	12.9	K
19.5	12.7	Sp

155229
Z Cor. Bor.

2196.6	10.0	Ba
2222.5	11.2	K
22.6	11.3	B

155947
X Herculis

2187.3	6.7	Pe
2206.7	6.3	Mu
14.7	6.3	
16.7	6.4	
19.7	6.4	
24.7	6.4	
27.7	6.4	

160021
Z Scorpii

2191.4	<11.8	L

160118
R Herculis

2193.5	8.9	Ja
2226.6	8.6	Hu
28.5	8.3	Pi
29.5	8.5	B

160210
U Serpentis

2196.6	12.3	Ba
2220.7	<12.3	Y

160625
RU Herculis

2190.4	12.8	Pe
96.6	12.2	Ba
2228.5	<12.3	Pi

161138
W Cor. Bor.

2196.6	12.3	Ba
2220.5	11.1	B
20.6	10.8	Y
28.5	10.2	E
28.6	10.4	Pi

161607
W Ophiuchi

2193.9	11.1	L_2

162119
U Herculis

J.D. 242	Est.	Obs.
2188.4	11.6	Pe_2
99.4	11.8	Pe
2221.6	10.7	V
28.6	10.9	Pi
29.5	9.3	B

162112
V Ophiuchi

2229.5	8.7	Cl

162542
g Herculis

2206.7	5.3	Mu
14.7	5.4	
15.6	6.0	Su
16.7	5.3	Mu
19.6	6.2	Su
19.7	5.4	Mu
22.6	6.2	Su
24.7	5.4	Mu
25.6	6.2	Su
27.7	5.6	Mu
28.6	6.2	Su
30.6	6.0	

162807
SS Herculis

2196.5	11.6	Ba
2215.6	10.6	Sp
15.6	10.3	B
26.6	10.6	Hu

162816
S Ophiuchi

2191.5	10.1	Ba
97.6	10.6	

163172
R Urs. Min.

2180.6	9.5	Ba
2222.6	10.1	M
26.6	10.4	Pi
31.5	10.1	Sp
31.5	10.1	B

163137
W Herculis

2195.4	<12.8	Pe
2220.6	13.4	Y

163266
R Draconis

2180.6	7.9	Ba
95.5	8.0	
2201.3	8.5	Pe
17.6	9.2	Pt
19.6	9.0	B
20.6	9.0	Y
22.6	9.1	M
26.6	9.3	Pi

164055
S Draconis

J.D. 242	Est.	Obs.
2217.6	9.1	Pt
22.6	9.1	M
28.6	8.9	Pi

164715
S Herculis

2180.6	8.0	Ba
2217.6	9.2	Pt
19.5	9.0	B
19.5	8.9	K
19.5	8.7	Sp
30.6	9.3	Pi

165631
RV Herculis

2188.4	12.2	Pe_2
91.5	12.0	Ja
97.6	12.0	Ba
2201.5	12.3	Ja
07.6	12.6	B
28.5	14.2	E

170215
R Ophiuchi

2174.4	7.6	Pe
79.9	7.6	Pe_2
80.6	6.8	Ba
87.4	7.6	Pe_2
96.4	7.8	Pe
2207.6	8.0	B
14.6	8.4	Pi
15.6	8.4	Ya
16.6	8.6	Pt
20.6	8.0	Hn
30.5	8.0	

170627
RT Herculis

2197.6	10.8	Ba
2219.6	11.0	B
19.6	11.1	K
28.6	11.3	Pi

171401
Z Ophiuchi

2173.4	10.8	Ja
94.4	11.4	
2215.6	11.9	Sp
15.6	11.8	B
28.5	11.6	E

171723
RS Herculis

2193.5	12.4	Ja
97.6	12.4	Ba
2201.5	12.7	Ja
26.6	12.0	Hu
28.5	11.2	E
28.6	12.0	Pi
29.6	11.9	B

172809
RU Ophiuchi

J.D. 242	Est.	Obs.
2197.6	10.1	Ba
2219.6	10.0	B

173557
TY Draconis

2194.4	9.2	Pe

175111
RT Ophiuchi

2197.6	10.0	Ba

175458a
T Draconis

2220.6	12.4	Y
28.6	11.9	E

175458b
UY Draconis

2220.6	10.8	Y
28.6	11.1	Pi
28.6	11.0	E

175519
RY Herculis

2191.4	9.4	Pe_2
99.3	9.4	Pe
2226.6	9.7	Hu
28.6	9.8	Pi
29.5	10.1	B

175654
V Draconis

2195.6	10.1	Ba
2228.6	10.6	Pi

180565
W Draconis

2191.5	11.1	Ba
2226.6	11.8	Pi

180531
T Herculis

2186.3	8.5	L
91.4	8.5	Pe_2
97.9	8.2	L_2
99.3	8.5	Pe
2217.6	8.8	Pt
21.6	8.6	V
22.6	8.4	M
23.6	8.5	Pi
26.6	8.2	Hu
31.5	8.4	B
31.5	8.5	Sp

180666
X Draconis

2191.5	<13.0	Ba
2226.6	11.0	Pi

VARIABLE STAR OBSERVATIONS, September, 1919—Continued

181031
TV Herculis

J.D. 242	Est.	Obs.
2159.4	11.0	L
91.4	12.4	Pe_2
98.4	11.8	L

181136
W Lyrae

J.D. 242	Est.	Obs.
2172.5	12.2	Ja
93.4	12.1	
2201.5	12.1	
22.6	10.3	M
23.6	10.1	Pi
26.6	10.0	Gd
28.6	9.5	B
29.6	9.4	Y

181103
RY Ophiuchi

J.D. 242	Est.	Obs.
2219.6	9.5	B
22.6	9.6	M

182224
SV Herculis

J.D. 242	Est.	Obs.
2197.6	12.8	Ba
2223.6	11.0	Pi
28.6	10.5	

183149
SV Draconis

J.D. 242	Est.	Obs.
2229.6	10.5	Y

183225
RZ Herculis

J.D. 242	Est.	Obs.
2197.6	12.3	Ba
2229.6	<12.5	Y

183308
X Ophiuchi

J.D. 242	Est.	Obs.
2180.6	7.0	Ba
92.9	7.4	L_2
2215.5	8.1	B
15.5	8.1	Sp

184134
RY Lyrae

J.D. 242	Est.	Obs.
2180.6	9.4	Ba
2226.6	9.7	Hu

184205
R Scuti

J.D. 242	Est.	Obs.
2126.4	5.2	L
26.5	5.8	Lt
27.5	5.7	
34.5	5.0	
37.5	4.8	
49.4	5.3	
55.5	5.5	
70.4	6.0	
73.4	5.9	Pe
73.5	6.0	Lt
74.3	6.0	Pe
74.4	5.9	Ja

R Scuti

J.D. 242	Est.	Obs.
2177.4	6.0	Lt
77.4	6.0	Ja
78.4	6.1	Lt
80.6	6.0	Ba
81.4	5.8	Ja
81.5	6.0	Lt
84.5	6.0	
86.3	5.8	Pe
86.4	5.5	L
86.5	6.1	Lt
88.4	5.7	Pe
89.4	5.7	Ja
91.4	5.2	L
91.5	5.7	Ba
92.5	6.0	Lt
93.4	5.7	Pe
94.4	5.7	Ja
95.5	5.5	Ba
98.3	5.3	L
99.3	5.8	Pe
99.5	5.5	Ja
2203.5	5.4	
05.6	5.7	Bh
06.6	5.6	Pt
06.6	5.7	Bh
06.7	5.3	Mu
07.6	5.7	Pt
07.7	5.6	Bh
08.6	5.7	
12.6	5.0	M
13.6	5.9	Pt
14.6	5.2	Pi
14.6	5.8	Pt
14.7	5.6	Mu
15.5	5.8	Bn
15.6	5.3	Su
15.6	5.8	Hk
16.6	5.8	Pt
16.7	5.8	Mu
17.6	5.7	Pt
18.7	5.8	
19.5	5.9	Hk
19.6	5.7	Su
19.7	5.6	Mu
20.6	6.0	Hu
20.6	5.5	Hn
21.6	5.9	Bh
21.7	5.9	Pt
22.6	4.8	M
22.6	5.6	Su
22.7	5.8	Mu
23.6	5.8	Pi
24.7	5.8	Mu
25.6	6.0	Hn
25.6	5.9	Pt
25.6	5.9	Su
26.6	6.0	Pi
26.6	5.8	Pt
27.7	5.8	Mu

R Scuti

J.D. 242	Est.	Obs.
2228.6	5.9	Pt
28.6	6.0	Pi
28.6	5.9	Ya
29.6	6.1	Bn
29.6	6.0	Hn
29.6	6.1	Su
30.6	6.1	Wg
30.6	6.0	Pi
30.6	6.0	Bh
30.6	6.3	Hn

184300
Nova Aquilae 3

J.D. 242	Est.	Obs.
2127.0	6.5	Lt_2
37.4	6.5	Lt
55.5	6.6	
72.0	6.7	Lt_2
74.3	6.7	Pe
80.1	6.6	Lt_3
89.4	6.8	Pe_3
89.4	7.0	L
89.5	6.7	Lt_2
94.4	6.8	Ja
99.3	6.9	Pe
99.4	6.9	L
2206.5	7.5	K
06.5	7.6	Cl
10.6	7.2	Pt_4
12.6	7.2	M
15.5	7.3	B
15.5	7.5	Sp
18.8	7.3	Pt_4
19.5	7.5	Cl
21.6	7.4	V
22.6	7.3	M
26.9	7.3	Pt_3
27.5	7.3	K
27.5	7.4	Cl
28.6	7.0	Ya

184633
β Lyrae

J.D. 242	Est.	Obs.
2219.6	3.4	Su
25.6	3.5	
26.6	3.2	
28.7	3.0	
30.6	3.2	

185032
RX Lyrae

J.D. 242	Est.	Obs.
2172.5	13.2	Ja
93.4	11.7	
99.5	11.4	
2223.6	12.2	Pi
28.7	11.7	

185243
R Lyrae

J.D. 242	Est.	Obs.
2206.7	4.2	Mu
14.7	4.2	

R Lyrae

J.D. 242	Est.	Obs.
2216.7	4.2	Mu
19.7	4.1	
20.6	4.5	Su
24.7	4.2	Mu
26.6	4.1	Su
27.7	4.2	Mu
28.6	4.4	Bh
29.6	4.4	Su
30.6	4.5	Bh

185634
Z Lyrae

J.D. 242	Est.	Obs.
2180.6	11.5	Ba
2228.6	13.6	B

190108
R Aquilae

J.D. 242	Est.	Obs.
2174.4	11.3	Ja
80.6	10.8	Ba
94.4	11.5	Ja
2220.6	9.9	B
30.6	10.3	Pi
33.6	10.3	E

190967
U Draconis

J.D. 242	Est.	Obs.
2180.6	11.0	Ba
95.5	11.4	
2226.6	12.2	Pi
27.6	11.9	Hu

190941
RU Lyrae

J.D. 242	Est.	Obs.
2214.7	11.8	M

190933a
RS Lyrae

J.D. 242	Est.	Obs.
2233.7	13.1	E

190926
X Lyrae

J.D. 242	Est.	Obs.
2180.6	9.0	Ba
2214.5	9.1	Pi
23.6	9.0	
28.6	9.0	

190925
S Lyrae

J.D. 242	Est.	Obs.
2197.6	14.0	Ba

190907
TY Aquilae

J.D. 242	Est.	Obs.
2191.6	10.9	Ba

191007
W Aquilae

J.D. 242	Est.	Obs.
2191.6	12.9	Ba

191017
T Sagittarii

J.D. 242	Est.	Obs.
2220.5	12.8	E

191019
R Sagittarii

J.D. 242	Est.	Obs.
2190.9	8.8	Pe_2
2201.4	9.9	Pe

191033
RY Sagittarii

J.D. 242	Est.	Obs.
2189.4	7.1	L
94.4	7.2	
95.6	6.5	Ba
98.3	6.9	L

191637
U Lyrae

J.D. 242	Est.	Obs.
2180.7	10.8	Ba
2214.5	12.0	Pi
14.7	11.0	M

192928
TY Cygni

J.D. 242	Est.	Obs.
2203.7	<12.4	M

193311
RT Aquilae

J.D. 242	Est.	Obs.
2220.6	12.9	B
33.7	12.3	E

193449
R Cygni

J.D. 242	Est.	Obs.
2195.5	<13.8	Ba
2214.5	<12.1	Pi

193732
TT Cygni

J.D. 242	Est.	Obs.
2180.6	7.5	Ba
2218.7	8.4	M
20.6	7.5	Hu
31.5	8.2	Pi

194048
RT Cygni

J.D. 242	Est.	Obs.
2195.5	9.0	Ba
2203.7	9.7	M
14.5	10.6	Pi
27.6	12.0	Hu
33.7	11.6	E

194348
TU Cygni

J.D. 242	Est.	Obs.
2195.6	11.0	Ba
2203.7	11.4	M
14.5	11.9	Pi
33.7	12.8	E

194632
χ Cygni

J.D. 242	Est.	Obs.
2172.5	9.5	Ja
74.3	9.7	Pe
80.6	9.2	Ba
91.5	10.3	Ja
2201.4	10.6	Pe
01.5	10.9	Ja
06.8	11.0	M
28.7	11.8	Pi
33.7	11.5	E

VARIABLE STAR OBSERVATIONS, September, 1919—Continued

194604
X Aquilae
J.D. Est.Obs.
242
2223.7 < 12.3 Pi

194700
η Aquilae
2215.6 4.5 Su
19.6 3.5
22.6 3.6
25.6 3.5
28.7 4.0
30.6 4.4

195116
S Sagittae
2206.7 5.8 Mu
14.7 6.0
16.7 6.1
19.7 5.3
22.7 5.5
24.7 5.2
27.7 5.2
28.6 5.5 Bn_2
29.5 5.4 Wg

195202
RR Aquilae
2220.6 13.2 B

195308
RS Aquilae
2229.6 14.1 B

195849
Z Cygni
2195.6 8.8 Ba
2203.7 9.5 M
21.6 10.8 V
28.7 11.1 Pi

200212
SY Aquilae
2197.6 13.0 Ba
2229.6 < 13.5 B

200357
S Cygni
2206.8 11.6 M

200647
SV Cygni
2180.7 8.3 Ba
2206.8 9.0 M
26.6 8.4 Hu
31.5 9.3 Pi

200715a
S Aquilae
2174.4 10.0 Ja
80.7 9.5 Ba
91.9 10.2 Ja_2
99.5 10.2 Ja

S Aquilae
J.D. Est.Obs.
242
2206.6 9.7 Cl
06.6 9.5 B
06.6 9.5 K
18.7 11.2 M
23.6 11.4 Pi

200715b
RW Aquilae
2180.7 9.0 Ba
2206.6 9.2 Cl
06.6 9.3 B
06.6 9.2 K
18.7 8.7 M
23.6 9.5 Pi
30.6 9.2 Ya

200812
RU Aquilae
2229.6 13.7 B

200822
W Capricorni
2229.5 12.0 Y
31.7 11.5 Me

200938
RS Cygni
2180.7 6.9 Ba
90.3 7.3 L
2210.2 7.4 M_2
21.7 8.3 Pt
23.5 7.0 Pi

200916
R Sagittae
2180.7 8.7 Ba
2218.7 8.7 M
30.6 8.6 Ya

200906
Z Aquilae
2174.4 12.2 Ja

201008
R Delphini
2190.4 11.5 L
2228.7 12.0 Me
29.6 12.6 B

201130
SX Cygni
2206.8 < 12.0 M

201121
RT Capricorni
2190.4 8.6 Pe
92.4 6.6 L
95.4 8.3 Pe
2217.7 8.3 Pt
31.7 7.8 Me

201647
U Cygni
J.D. Est.Obs.
242
2180.6 7.3 Ba
2213.7 6.9 M
18.7 7.2 Pt
26.7 7.3 Ya
30.0 7.0 Pi_2

202539
RW Cygni
2180.7 6.9 Ba
2210.2 8.2 M_2
23.5 8.9 Pi
26.8 8.6 M

202817
Z Delphini
2220.6 10.0 Pi
28.7 9.8
29.6 9.4 B
33.7 9.0 E

202954
ST Cygni
2195.6 12.2 Ba
2206.8 12.1 M
15.6 12.5 Pi
20.6 11.5 Hu
28.7 11.7 Pi

202946
SZ Cygni
2180.9 9.3 Ba
96.6 9.0 Ba_2
2210.2 9.3 M_2
26.6 9.6 Hu
31.5 9.4 Pi

203226
V Vulpeculae
2206.8 8.6 M
17.7 8.9 Pt
20.6 9.2 Pi
28.7 9.7

203611
Y Delphini
2200.6 12.6 Ja_2
28.6 13.5 B

203816
S Delphini
2222.5 9.5 K
22.6 9.5 Cl
22.6 9.3 B
25.5 9.4 V

203905
Y Aquarii
2188.4 12.0 Pe
95.3 12.1

204215
U Capric.
J.D. Est. Obs.
242
2229.5 < 12.8 Y

204405
T Aquarii
2172.3 8.3 Pe
90.9 9.0 Pe_2
95.3 9.0 Pe
2217.7 10.0 Pt
19.6 10.3 B
19.6 10.3 K

204846
RZ Cygni
2220.5 < 12.4 Pi

205030a
UX Cygni
2206.8 11.6 M

205017
X Delphini
2229.6 12.7 B

205923
R Vulpeculae
2208.7 8.1 M
17.7 8.7 Pt
27.6 8.1 Hu
30.6 9.1 Pi

210129
TW Cygni
2203.7 < 12.0 M

210116
RS Capric.
2196.4 8.4 Pe
2216.6 8.4 Pt

210382
X Cephei
2195.6 < 13.0 Ba
2226.6 < 12.5 Pi

210868
T Cephei
2180.7 9.4 Ba
90.3 10.1 L
95.6 10.0 Ba
2207.5 10.4 B
26.6 10.7 Pi
28.6 9.3 Hu

211614
X Pegasi
2191.6 10.6 Ba
2229.7 14.3 Me

213244
W Cygni
J.D Est.Obs.
242
2110.4 5.7 L
26.4 5.7
86.4 6.7
90.3 6.7
92.3 6.5
98.3 6.3

213678
S Cephei
2195.6 9.0 Ba
2226.6 10.6 Pi

213753
RU Cygni
2180.7 8.6 Ba
2206.8 8.7 M
18.7 8.8
20.5 8.8 Pi

213843
SS Cygni
2110.4 12.0 L
26.4 10.8
73.4 11.2 Ja
74.4 11.2
75.4 11.3
80.6 11.4 Ba
86.3 11.3 Pe
86.4 10.9 L
89.4 11.5 Ja
90.3 11.1 L
91.4 11.0
91.5 11.7 Ba
92.3 11.4 L
93.5 11.9 Ja
95.3 11.3 L
95.5 11.7 Ja
95.6 11.4 Ba
96.5 11.4
97.6 11.5
98.3 11.6 L
98.6 11.4 Ba
99.5 11.6 Ja
2200.4 11.3 L
01.6 11.5
02.6 11.7 B
06.5 8.6 K
06.5 8.7 B
06.5 8.1 Ja
06.5 8.6 Cl
06.6 8.5 Pt
06.8 8.3 M
07.5 8.6 B
07.6 8.5 Pt
08.7 8.2 M
09.6 8.3
09.9 8.4 Pt
12.6 8.4 M
13.5 8.3 Pi

VARIABLE STAR OBSERVATIONS, Segtember, 1919—Continued.

SS Cygni

J.D. 242	Est.	Obs.
2213.6	8.7	Pt
13.7	8.4	M
14.6	8.4	Pi
14.6	8.7	Pt
14.7	8.5	M
15.5	8.8	B
15.5	8.7	Sp
51.6	8.4	Pi
15.7	8.6	Pt
16.6	9.0	
17.6	9.5	
17.8	9.5	M
18.7	9.8	Pt
18.7	9.7	M
19.5	10.0	K
19.5	9.9	B
19.5	10.2	Bu
19.5	10.2	E
19.5	9.7	Sp
19.8	10.2	M
20.5	10.1	B
20.5	10.3	Pi
20.5	10.4	E
20.6	10.2	Hu
22.5	11.1	B
22.5	10.9	K
22.5	11.0	Cl
22.6	10.6	M
23.5	10.9	B
23.5	10.9	Pi
25.6	11.1	V
26.6	11.2	Hu
26.6	11.5	Pi
26.8	11.6	M
27.6	11.9	Hu
27.6	11.3	Pi
27.7	11.1	E
28.5	11.4	Cl
28.5	11.5	B
28.5	11.5	Sp
28.5	11.3	Pi
28.6	11.2	E
28.7	11.6	Me
28.8	12.0	M
29.5	11.7	Cl

SS Cygni

J.D. 242	Est.	Obs.
2229.5	11.5	B
29.6	11.3	Pi
29.8	11.3	E
30.5	10.6	Cl
30.6	11.4	Pi
31.5	11.1	Cl
31.5	11.4	Sp
31.5	11.4	B
31.5	11.2	K
31.5	11.4	Pi
33.7	11.2	E
39.8	11.8	

213937
RV Cygni

J.D. 242	Est.	Obs.
2180.7	6.7	Ba
2211.7	8.2	M_2
13.5	7.9	Pi
14.6	8.0	Pt
20.6	7.5	Hu

214024
RR Pegasi

J.D. 242	Est.	Obs.
2173.5	13.5	Ja
2204.6	13.5	

215605
V Pegasi

J.D. 242	Est.	Obs.
2173.5	10.0	Ja
93.5	10.9	
2204.6	11.7	
29.7	12.9	Me

220412
T Pegasi

J.D. 242	Est.	Obs.
2191.6	11.9	Ba
93.4	12.0	L
2228.6	13.3	B
29.7	13.5	Me

220613
Y Pegasi

J.D. 242	Est.	Obs.
2173.5	11.0	Ja
91.6	12.3	Ba
93.5	12.7	Ja
2201.5	13.5	
21.7	<13.6	Me

220714
RS Pegasi

J.D. 242	Est.	Obs.
2173.5	11.8	Ja
91.6	12.6	Ba
93.5	12.5	Ja
2201.5	12.6	

222439
S Lacertae

J.D. 242	Est.	Obs.
2180.7	9.5	Ba
90.4	8.7	L
2230.8	8.7	M
31.5	8.5	B
31.5	8.4	Sp
31.5	8.5	Pi

222557
δ Cephei

J.D. 242	Est.	Obs.
2226.6	3.7	Su
27.6	3.9	
28.7	4.2	
29.6	4.0	
30.6	3.0	

223841
R Lacertae

J.D. 242	Est.	Obs.
2230.8	13.2	M

225120
S Aquarii

J.D. 242	Est.	Obs.
2191.6	8.2	Ba
95.5	8.3	Ja
2229.6	8.2	Y

225914
RW Pegasi

J.D. 242	Est.	Obs.
2180.7	11.1	Ba
2229.7	13.0	Me

230110
R Pegasi

J.D. 242	Est.	Obs.
2188.4	<12.2	Pe
2231.7	13.5	Me

230759
V Cassiop.

J.D. 242	Est.	Obs.
2172.3	7.5	Pe
74.4	7.6	Ja
80.7	7.6	Ba
88.8	8.3	Pe_2
95.6	8.4	Ba
2201.4	8.6	Pe
16.6	9.5	Pt
22.5	9.3	Cl
22.6	9.3	K
22.6	9.4	B
25.6	9.1	V
27.8	9.6	M
28.6	9.0	Hu
29.6	9.8	Pi

231425
W Pegasi

J.D. 242	Est.	Obs.
2173.5	11.5	Ja
92.4	11.3	L
93.5	11.8	Ja
2201.5	12.1	
29.7	11.9	Me

231508
S Pegasi

J.D. 242	Est.	Obs.
2190.9	11.3	Pe_2
99.4	11.6	Pe
2229.7	10.1	Me

233335
ST Androm.

J.D. 242	Est.	Obs.
2180.7	10.1	Ba
95.5	10.9	Ja
2219.8	11.0	M
20.6	11.1	Pi
27.6	10.9	Hu
29.6	10.5	B

233815
R Aquarii

J.D. 242	Est.	Obs.
2191.7	9.9	Ba
94.4	9.7	Pe
2201.4	9.7	

233956
Z Cassiop.

J.D. 242	Est.	Obs.
2195.6	<13.4	Ba

235053
RR Cassiop.

J.D. 242	Est.	Obs.
2227.8	11.0	M
28.5	11.5	Cl
28.5	10.8	B
28.5	11.2	Sp
29.6	10.9	Pi

235209
V Ceti

J.D. 242	Est.	Obs.
2195.5	11.7	Ja

235350
R Cassiop.

J.D. 242	Est.	Obs.
2180.7	7.2	Ba
95.6	7.5	
2222.6	8.6	M
23.5	8.5	B
25.6	8.6	V
29.6	9.6	Pi

235525
Z Pegasi

J.D. 242	Est.	Obs.
2173.5	8.5	Ja
93.5	8.7	
2204.6	8.9	
26.8	9.5	M
29.7	9.8	Me

235855
Y Cassiop.

J.D. 242	Est.	Obs.
2180.7	<12.5	Ba
91.6	11.5	
2225.6	10.0	V
27.8	9.7	M
29.6	9.7	Pi

235939
SV Androm.

J.D. 242	Est.	Obs.
2191.6	13.0	Ba
2229.6	12.0	Y
29.6	12.5	Pi

No. of Observations: 1167. No. of Stars Observed: 238. No. of Observers: 27.

The following observers contributed to this report:—Messrs. Bancroft, Bouton, Brown, Bunch, Burbeck, Clement, Eaton, Godfrey, Hodgkinson, Henckel, Hunter, Janczewski, Kimball, Lacchini, Luyten, McAteer, Meeker, Mundt, Peltier, de Perrot, Pickering, Spinney, Suter, Vrooman, Woglam, Yalden, Miss Young.

IDA E. WOODS,
Acting Secretary.

ANNUAL REPORT OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

RECORD OF OBSERVATIONS

1918	Bancroft (Ba)	Bouton (B)	Brown (Bn)	Clement (Cl)	Dawson (δ)	Delmhorst (De)	Eaton (E)	Hay (Ha)	Houdard (Hd)	Hunter (Hu)	Janczewski (Ja)	Kimball (K)	Lacchini (L)	Lincoln (Li)	Luyten (Lt)	McAteer (M)	Meeker (Me)	Mundt (Mu)	Murry (My)	Parkhurst (Pa)	Miss Parsons (Pr)	Peltier (Pt)	de Perrot (Pe)	D. Pickering (Pi)	Reardon (Re)	Rhorer (Ro)	Spinney (Sp)	Suter (Su)	Tapia (Tp)	Vrooman (V)	Whitehorn (Wh)	Woglam (Wg)	Yalden (Ya)	Yont (Yo)	Miss Young (Y)	Additional Obs.	Total Observations	Number of stars observed	No. of Observers
Nov.		122				9			13	32			23			71	12	32	9			55	142	26	13				18	75				81	14	747	196	19
Dec.		33			125					49				43	340	77	30	17				70	58	46	7			89	37	40				40	5	1106	265	16
1919																																						
Jan.		23							3	36	16				247	11		17	3			19		29						17			45		466	120	11
Feb.		25			166					42					208	118		13	5			6	17					113	15	24			64		816	223	12
Mar.		15								35						48		13	9			43		33					11	37		9	46	6	305	131	12
Apr.	98	88			149											115		8	12			53		47				95	19	32	4		38	1	769	247	15
May		86			81	18				15	21				234	104		9	32			53		100		5		101	14	21	10	3		51	21	979	251	26
June		33			46			32		10	66				88	66		24	15			56	39		14			43			5	3		21	5	566	244	20
July		69								12	22				77	136		61				61		42		6	4		9			5				504		
Aug.	102	80	3	4	102						62	3				124		38	28	56	18	57	40				6	37	17		11				788	288	19
Sept.		113	6	13				14			52	10				127		24	34	4		55	32						13						497		
Oct.	134	79	6	25			44			21	75	22	76		36	145	15	40				63	146	118			18	33	13		4	7		25	22	1167	238	27
Total	334	766	15	42	669	27	58	32	16	252	314	35	99	43	1230	1142	57	296	147	60	18	591	474	441	20	25	18	43	478	166	246	34	18	19	411	74	8710	352	53

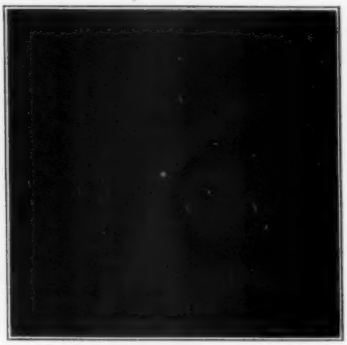
ANNUAL RECORD OF THE ASSOCIATION.

Year	Number of Observations	No. of stars Observed	Number of Observers
1912	6180	175	19
1913	12914	200	20
1914	14506	255	28
1915	14724	282	29
1916	11261	290	30
1917	15788	332	43
1918	16112	380	34
1919	8710	352	53
	100195		

COMET AND ASTEROID NOTES.

Photographs of Comet *b* 1919 (Brorsen-Metcalf).— The accompanying cuts were prepared from two photographic prints sent us by Prof. D. W. Morehouse of the Drake University, Des Moines, Iowa. Each photograph was given an exposure of one hour.

August 30, 10:45-11:45



September 15, 9:15-10:15

Photographs of Comet *b* 1919 (Brorsen-Metcalf) taken by D. W. Morehouse at Drake University Observatory, Des Moines, Iowa.

On August 30 the comet was high in the sky and the photograph shows many star trails. The rate of motion of the comet was not well known at that time and so the comet's image is drawn out into a hazy streak about two millimeters long, shown about half inch to the right of the center of the cut. The arrow on the left point to another suspicious object which has not been identified.

On September 15 the comet was low down in the northwest, so that few star trails show, while the comet image is a round bright spot in the center of the cut.

Elements of Comet *b* 1919.— A cablegram received here from Professor Elis Strömgren, of Copenhagen, contains the following elliptical elements of Metcalf's First Comet, computed by Braae and Fischer-Petersen.

Time of perihelion passage	(T)	1919, October 17.16 G.M.T.
Perihelion minus node	(ω)	129° 53′
Longitude of node	(Ω)	310° 29′
Inclination	(i)	18° 53′
Perihelion distance	(q)	0.486
Eccentricity	(e)	0.9600
Periodic time	(P)	42.47 years

The message contains the comment "Probably two revolutions since 1847."

Harvard College Observatory,
Bulletin 695.

New Elements of Metcalf's First Comet *b* 1919.— In the *Lick Observatory Bulletin* No. 324 Mr. H. M. Jeffers gives new elements of Metcalf's first comet of 1919, determined by differential correction of his preliminary elements, with the condition that the period of the resulting orbit should be the difference between the perihelion times of Brorsen's comet of 1847 and Metcalf's comet. A comparison of the conditioned elements with Gould's first elements of Brorsen's comet is given below, and seems to show conclusively the identity of the two comets. Observations up to Sept. 18 are quite closely represented by these elements.

	Conditioned Elements		Gould's Elements	
T =	1919 Oct. 16.8625 G.M.T.		1847 Sept. 9.5518 G.M.T.	
ω =	129° 29′ 06″.0	1919.0	129° 21′ 18″	1919.0
Ω =	310 45 22.1		310 49 29	
i =	19 12 49.3		19 08 22	
ϕ =	76 24 36.0		76 19 44	
e =	0.972002		0.971669	
log q =	9.685614		9.688402	
log a =	1.238488		1.236136	
μ =	49″.2351		49″.6367	

The portion of the ephemeris for November given in the *Lick Bulletin* is as follows, and shows that the comet may be observed by southern observers in the morning. It will be about 5° west of the first magnitude star Spica (αVirginis) on the morning of November 12.

Ephemeris for Greenwich Mean Midnight.

	true α			true δ		log Δ	Br.
	h	m	s	°	′		
1919							
Nov. 1.5	12	30	36	−4	01.4		
2.5		33	14	4	45.8		
3.5		35	51	5	29.1	0.1000	0.27
4.5		38	28	6	11.5		
5.5		41	04	6	52.8		
6.5		43	40	7	33.3		
7.5		46	15	8	12.8	0.1253	
8.5		48	49	8	51.5		
9.5		51	22	9	29.2		
10.5		53	54	10	06.1		
Nov. 11.5	12	56	25	−10	42.2	0.1476	0.15

Brightness Aug. 22 = 1.00

Search Ephemeris for Giacobini's Comet 1900 III.—I am sending you a search Ephemeris of Giacobini's Comet 1900 III, which was rediscovered by Dr. Zinner at its return in 1913. It passed perihellion on November 1, 1913. It should pass perihelion again early next June. The ephemeris and constants below are based upon the following elements by Giacobini:

T =	1913 Nov. 1.893 G.M.T.			log a =	0.54560
	°	′	″	log q =	9.97086
π =	7	04	33	μ =	539.000
Ω =	195	36	18	a =	3.5124
i =	30	33	06	q =	0.9851
ϕ =	47	12	15	Aph. =	6.0896

Constants for the Equator:

$$x = r\,(9.99590)\ \sin\,(283\ 31\ 26\ +\ u)$$
$$y = r\,(9.99753)\ \sin\,(194\ 22\ 16\ +\ u)$$
$$z = r\,(9.23880)\ \sin\,(321\ 51\ 11\ +\ u)$$

SEARCH EPHEMERIS FOR GIACOBINI'S COMET 1900 III.

	α			δ			log *r*	log Δ
1920	h	m	s	°	′	″		
Jan. 1	17	29	26	—4	31	07	0.33864	0.48029
9	17	46	43	—4	15	54	0.32350	0.46445
17	18	04	49	—3	51	15	0.30758	0.44747
25	18	23	48	—3	15	55	0.29084	0.42919
Feb. 2	18	43	43	—2	29	48	0.27326	0.41001
10	19	04	38	—1	32	07	0.25474	0.38995
18	19	26	41	—0	22	22	0.23528	0.36931
26	19	49	57	+0	59	25	0.21480	0.34823

FRANK E. SEAGRAVE.

New Elements of Comet *d* 1918 (Schorr).—In the *Lick Observatory Bulletin* No. 324 Mr. H. M. Jeffers gives the following elements, depending upon Schorr's observations of November 24, December 10 and 31.

Epoch 1919 January 0.5 G.M.T.

$$M = 13^\circ\ 37'\ 22''.1$$
$$\omega = 279\ 28\ 08.0$$
$$\Omega = 117\ 51\ 00.8 \quad 1918.0$$
$$i = 5\ 35\ 10.4$$
$$\phi = 27\ 55\ 54.0$$
$$\log a = 0.549844$$
$$\mu = 531''.180$$
$$T = 1918\ \text{Oct.}\ 0.1733\ \text{G.M.T.}$$

COMMUNICATIONS.

Visit to Tokyo Observatory.—Wishing to visit my old home, I obtained leave of absence for the spring term in the University of California. I took a steamer at Seattle on May 1. Dr. Young of the Dominion Astrophysical Observatory and his wife, the daughter of Professor Aitken of the Lick Observatory, are old acquaintances and I wished to visit this great observatory but time did not allow me to do that. On May 21 I visited the Tokyo Observatory. Director Terao was not there but Professor Saotome and the staff received me very cordially and explained the various instruments. I saw the 8-inch equatorial refractor with an 8-inch objective prism camera attached to the side of it. This is used to photograph the stellar spectra. Professor Saotome showed me many beautiful spectra of Nova Aquilae taken with this camera. He is also studying the sun with a spectroheliograph. The instrument is of medium size but is of splendid design and beautiful pictures of calcium flocculi are obtained.

There is an 8-inch Brashear photographic doublet with several cameras of portrait lenses attached to it. There is also an 8-inch meridian circle, but this is

not properly mounted. Riefler clocks, chronometers, and several small telescopes are there also.

This observatory is in the center of the smoky city and the seeing is not very good, so they have planned to move the observatory to a better site about seven miles from the present location and the buildings have been erected. So they are ready to move as soon as funds are available. The Educational Department of the Japanese Government is handicapped for lack of funds. It will be some time before sufficient funds are available to move the observatory.

The library of the observatory is well stocked with books and periodicals.

The Astronomical Society of Japan has its headquarters in this observatory and has 600 members. Dr. S. Hirayama is President, and Dr. K. Hirayama, Vice-President. The Society holds meetings twice a year, one for the discussion of astronomical topics, the other for observation. The Observatory receives many groups of visitors, mostly of students, each week. The Society publishes a monthly paper, named *Astronomical Herald*, which is distributed widely. Thus the Observatory and the Society are endeavoring to popularize this interesting science in Japan. I was very much impressed by the admirable work done by the astronomers there in spite of the poor atmospheric conditions and lack of funds. I believe that in the new location with larger telescopes splendid results will be obtained.

I take this opportunity to express sincere thanks to Professor Saotome, Dr. K. Hirayama, and the staff of the Observatory for their hospitality.

M. YAMASAKI.

Berkeley, Calif.
September 14, 1919.

The Aurora of October 22, 1919.—A rather brilliant glow near the northern horizon gave promise early in the evening of a good auroral display. It was not, however, until 11:30 P. M. (summer time) that any pronounced feature began to be visible.

At this time large patches of light began to detach themselves from the main body near the horizon, and traveled upwards toward the zenith with a progressive wave-like motion, of considerable rapidity. α Lyrae was just visible through the swiftly moving clouds of light. At 12:00 midnight, the auroral arch extended up through Cepheus, while occasional streamers shot beyond. The ribbon-like effect so often noted by explorers in the North was seen very clearly. Special attention was given to the detection of a crackling sound, supposed by some to be connected with an auroral display, but none could be heard, although the night was still and there was no wind to rustle the leaves or grass.

At 12:25 a meteor, one of the Cepheids, darted across the sky, and as if it were a signal, the auroral activity began to increase rapidly. In a few seconds the arch of light was extended out through Cassiopeia and Perseus nearly to the Pleiades and Andromeda. Deneb and Vega marked the extent of the arch in the west. This northern section of the sky seemed filled with swiftly moving, waving patches and sprays of light while only the brighter stars were visible. Some of the streamers would spray out like a fountain and wave back and forth as if blown by the wind. This intense activity lasted about five minutes and then died away as rapidly as it began, leaving only a few stationary clouds of light near β Persei and 61 Cygni.

At 12:45 A. M. another outburst occurred similar to the above, but marked

by larger masses of light and slower motion. The farthest extent of the light arch this time was to α Andromedae. At 12:55 A. M. the display had again died away and although occasional stray curtains of light still waved low in the north, no more increases in activity took place. The magnetic needle showed great perturbation during the duration of this exhibit. This display was a remarkable example of aurora borealis and was much better than the aurora observed here on September 18, 1919. LEWIS J. BOSS.

North Scituate, R. I.
October 23, 1919.

GENERAL NOTES.

Professor William F. Rigge, director of the Creighton University Observatory, has given a very interesting account of the recent Scientific Meetings at Ann Arbor, in the *Creighton Courier* for October 1, 1919.

Group Photographs of Astronomers.— Prof. R. H. Curtiss of the Detroit Observatory writes the following concerning the group photographs which are taken at the Ann Arbor meeting of the American Astronomical Society:

"Copies of photographs of the three groups—the large group, the Lick Observatory group, and the Ann Arbor Group—made during the recent meeting of the American Astronomical Society may be obtained by addressing Lyndon & Company, Ann Arbor, Mich. The price is fifty cents for each photograph plus fifteen cents for postage and packing."

Harvard College Observatory Astronomical Telegrams.— In view of the establishment of the Bureau Central International des Télégrammes Astronomiques, at Uccle, Belgium, by the Union Astronomique Internationale, for the reception and distribution of astronomical telegrams, this Observatory announces that it is its purpose to coöperate with the new Bureau.

The expense of cabling announcements directly to and from Europe is great, and it seems unnecessary that this burden should be incurred separately by each subscriber. This Observatory therefore stands ready, as in the past, to transmit by cable telegrams received here, and simultaneously to distribute them to subscribers in America. It will also transmit to subscribers, at the actual cost of telegraphing, cablegrams received from Europe.

The bulletin service of the Observatory, by which printed announcements of telegraphic information are distributed by mail, will be continued.

S. I. BAILEY, Acting Director.

Cambridge, Mass., U.S.A., October 22, 1919.

Coronium in Natural Gas?— Messrs. H. P. Cady and H. McK. Elsey, of the University of Kansas report in *Science* that they are developing new spectroscopic equipment and methods for the purpose of definitely settling the question whether certain lines that have been frequently detected in the spectrum of specimens of helium, obtained from natural gas, are due to coronium, as has been suspected. Living and Dewar observed some "wild" lines in specimens of Bath gas which they suggested might belong to the spectrum of coronium. Cady and

McFarland found lines corresponding closely in wave-length with the lines of coronium in the spectroscopic examination of samples of helium from natural gas, as reported in a publication of the Kansas University Geological Survey, "The Composition of Natural Gas."

Length of a Sunspot Apparition.—The following statement is taken from a paper by Mr. E. Walter Maunder in the Monthly Notices of the R.A.S. for April 1919, p. 454:

"The maximum length of time that a sunspot can, under ordinary conditions, be seen during one apparition is just 14 days; this interval taking it from very close to the east limb to very close to the west limb; more generally it is seen on only 13 or 12 days."

Period and Elements of the Orbit of ζ Ursae Majoris.—In *A.N.* No. 4996 Mr. A. Hnatek of Vienna, Austria, gives a new determination of the orbit elements of the spectroscopic binary ζ^1 Ursae Majoris, from spectrograms taken at Potsdam 1901-96 and at Vienna in 1917-18. He finds for the most probable period 20.5315 days, and for the range of velocity $+121$ km. to -148 km.

ELEMENTS.

Periastron: 1917 Sept. 16.427 G.M.T.

$\omega = 101^\circ\ 24'$

$e = 0.508$

$a \sin i = 32700000$

$m_1 + m_2 = 3.32 \odot / \sin^3 i$

Ten New Variable Stars.—In Circular 218 of Harvard College Observatory ten new variable stars are announced, all having been found on Maps 25 and 28 of the Harvard Map of the Sky. Fifteen previously known variables were found in the same search of these two maps. The data concerning the 10 new variables are given in the following table:

Designation	Constellation	B.D.No.	R.A.1900	Dec. 1900	Magnitude		Range
		°	h m s	° ′	Br.	Ft.	
053106	Orion	+6 971	5 31 06.3	+6 46.2	9.5	10.3	0.8
061606	Monoceros	+6 1208	6 16 03.9	+6 31.0	8.6	9.6	1.0
062105	Monoceros	...	6 21 40.6	+5 26.1	10.2	(11.3)	1.1
064604	Monoceros	+4 1476	6 46 39.1	+4 53.1	8.7	9.4	0.7
112800	Leo	...	11 28 46.4	0 31.3	10.0	11.2	1.2
113311	Leo	...	11 33 23.2	+11 06.7	10.5	11.2	0.7
114605	Virgo	−4 3155	11 46 43.6	− 5 12.3	9.8	10.6	0.8
115903	Virgo	+3 2593	11 59 28.8	+ 3 10.6	10.0	11.1	1.1
120300	Virgo	+0 2900	12 03 26.5	+ 0 04.7	9.9	10.7	0.8
121600	Virgo	...	12 16 08.8	+ 0 55.2	10.2	11.0	0.8

List of 3162 Stars for Latitude Work.—A very useful list of stars suitable for latitude determinations in the northern hemisphere has been prepared by Mr. R. M. Stewart of the Dominion Observatory, Ottawa, Canada, and type-written copies have been distributed to various observatories, pending the accurate determination of the positions of such of the stars as have received too little attention in the past.

The list includes, with a few exceptions, all stars north of 20° declination, and many between 10° and 20°, in Boss's Preliminary General Catalogue for 1900; all those, between the same limits of declination, in Ambronn's Sternverzeichniss for 1900; and such additional stars as have been used at the Dominion Observatory in latitude observations.

The exceptions are stars fainter than magnitude 7.5, and close unequal doubles considered unsuitable for measurement.

Parallaxes of Two Stars in Pisces.—In the *Astronomical Journal* No. 758 Professor Frank Schlesinger, director of the Allegheny Observatory, gives preliminary parallaxes of two swift moving stars in Pisces. One is the star Boss P.G.C. 171, magnitude 6.0, for which Boss found the annual proper motion $+0^s.0500$ and $-1''.144$ (or about $1''.4$ toward southeast). The other star is one of magnitude 12, about 14′ northeast of Boss 171, which is moving in nearly the same direction but more than twice as fast (about $3''.0$ annually). The positions of the stars for 1900.0 are

Mag.	R.A.	Dec.
6.0	$0^h\ 43^m\ 08^s.18$	$+4°\ 45'\ 59''.1$
12.3	0 43 52	+4 55

The parallaxes found by Professor Schlesinger, from 8 Allegheny photographs, are $+0''.14 \pm 0''.008$ and $+0''.27 \pm 0''.012$, respectively. The brighter star is thus nearly twice as far away as the fainter, showing that the two do not form a physical system.

These results confirm those previously obtained by Chase, $+0''.16 \pm 0''.048$, and Flint, $+0''.18 \pm 0''.040$, for the bright star; and by van Maanen, $+0''.244 \pm 0''.008$ for the faint star.

New Double Star.—The following double star (No. 34 in my list) was recently discovered and measured with the 18½-inch refractor of the Dearborn Observatory of Northwestern University, at Evanston, Ill.

34 B.D. $+45°$ 1940 ($9^m.3$), 1880.0 $\alpha\ 11^h\ 27^m\ 09^s$ $\delta + 45°\ 25'$

$10^m.7 \ldots 10^m.8$

1919.479	162°.6	1″.71
.481	162.8	1.80
1919.480	162°.7	1″.76

The magnitudes of the components have been deduced from the combined magnitude of the star ($10^m.0$) on the Harvard photometric scale.

FREDERICK C. LEONARD.

A New Star in Sagitta.—Harvard College Observatory Bulletin 691 announces a new star recently discovered by Miss Mackie in the course of a systematic examination of photographs covering the Milky Way. Unfortunately the discovery was made six years after the appearance of the star and so its phenomena can be studied only on the photographs which happen to have been taken of the region in which the star appeared.

Details of the results obtained from the Harvard collection of plates are given in the Harvard College Observatory Circular 219. The first image of the star

is found on a plate taken November 21, 1913, when the photographic magnitude was 10.0. Two plates taken the next night, November 22, 1913, give the magnitude 7.2 and 7.1 respectively. Eight plates obtained on November 25, 26, December 3, 5, 11, 15, 19 and 27, show that the star gradually waned from magnitude 8.0 to 10.0. By June 17, 1914, it had diminished to magnitude 13.8, and on October 18, 1916, it was fainter than a 14.5 magnitude star, to which it is very close and upon which its image, when bright, was superposed.

The Harvard designation of the star is

200317 Nova Sagittae R.A. $20^h\ 03^m\ 04^s$, Dec. $+17°\ 24'.3$ (1900).

On the Existence of External Galaxies.—In the *Publications* of the Astronomical Society of the Pacific for October, 1919, Mr. Harlow Shapley, of the Mount Wilson Observatory, gives a résumé of the arguments which have been brought out by various astronomers in favor of and opposed to the "island universe" hypothesis of the spiral nebulae. After a brief discussion of these arguments he states the following conclusions:

"Observations and discussion of the radial velocities, internal motions, and distribution of spiral nebulae, of the real and apparent brightness of novae, of the maximum luminosity of galactic and cluster stars, and finally of the dimensions of our own galactic system, all seem definitely to oppose the 'island universe' hypothesis of the spiral nebulae. Data relating to proper motion are also in better harmony with the hypothesis that spiral nebulae are not stellar systems. The evidence now supporting the 'island universe' interpretation appears unconvincing, for many of the best arguments formerly proposed on that side of the question have been invalidated or much weakened by recent research. We have, however, no evidence that somewhere in space there are not other galaxies; we can only conclude that the most distant sidereal organizations now recognized—globular clusters, Magellanic clouds, spiral nebulae—cannot successfully maintain their claims to galactic structure and dimensions."

The American Association of Variable Star Observers will hold its annual meeting at the Harvard College Observatory on the afternoon and evening of Saturday, November 8, 1919. Matters of considerable importance are to be acted upon, chief among them being the election of officers for the ensuing year and a proposed amendment to the constitution which aims to allow the Association to use a part of the Life Membership Fund for the creation of a Telescope Fund.

Nebulous Lines in R Aquarii.—The following telegram has just been received from the Harvard College Observatory: "Hale telegraphs Merrill finds strong bright nebulous lines N_1, N_2 and 4363, in spectrum of Md star R Aquarii *233815* about one month before predicted maximum.

S. I. Bailey."

Cambridge, Mass. Oct. *27*, 1919.